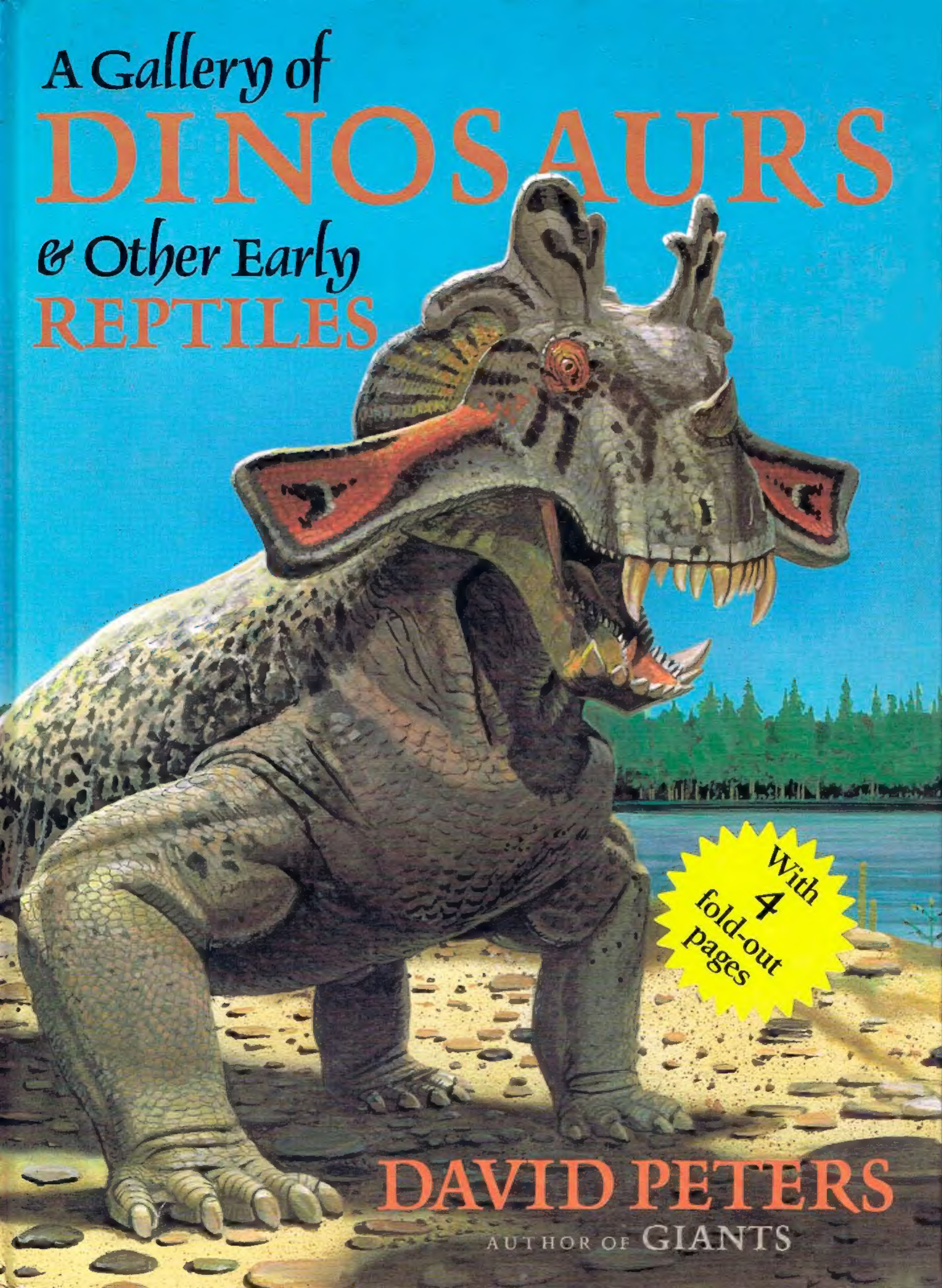
A Gallery of DINOSAURS & Other Early REPTILES



With 4 fold-out pages

DAVID PETERS

AUTHOR OF GIANTS

A Gallery of DINOSAURS & Other Early REPTILES

DAVID PETERS

Alfred A. Knopf New York

Dedicated to
my wife, Karen,
and my daughters, Stephanie and Ann,
who make coming upstairs
after a long day spent in the studio
such a joy

Sincere thanks are due the following, who either directly or indirectly contributed to this book:

The multitude of scientists who make discoveries in the field, in their labs, and in their cladograms, especially Dr. Kevin Padian, this book's scientific adviser.

The many artists/scientists who illustrate their findings so that nonscientists may understand, especially Mark Hallett, Greg Paul, Dr. Robert Bakker, Dr. Ken Carpenter, Doug Henderson, and Zdenek Burian.

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Cover illustration: *Estemmenosuchus*

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Introduction

One hundred spectacular dinosaurs and other prehistoric reptiles march, fly, and swim through the pages of this book. Its portrait gallery format is designed for the casual, browsing reader who wants to know what these animals looked like, what sort of life they led, and how we know about them today. Though not intended to be a systematic introduction, the book relates the various family groups of reptiles to each other and includes some of the latest theories in this ever-changing field.

Dinosaurs dominate these pages, as they did the earth at one time, but they were by no means the only giant reptiles of long ago. The nondinosaurian reptiles, usually glossed over in most popular books, are given equal status here. Among the featured animals are the giants of each family along with a few smaller members and some other interesting varieties.

Clues to the Past

Fossils are the remains of prehistoric life, usually preserved in stone. We know about dinosaurs and such because we've found their fossil footprints, stomach contents, eggs, skin, and especially their bones and teeth. From these clues scientists can reconstruct not only an animal's size and shape but also the way it moved, what it ate, and how fast it grew.

The bones and teeth of most animals do not fossilize. Usually scavengers and bacteria destroy the remains. Occasionally, however, a carcass becomes buried under sediment (typically silt, sand, or volcanic dust) and is preserved long enough to form a fossil. In time, minerals seep through the sediment and convert the buried bones and teeth into stone. Although fossilization occurs only rarely, over millions of years it has happened often enough to give us an accurate picture of life in the past. A rich location can preserve many years' worth of living things within layer upon layer of rock.

The Evolution of Early Reptiles

Around 400 million years ago it seems there were predatory fish living in equatorial lakes that were poor in oxygen content and subject to periodic drought. These fish breathed with gills underwater and with simple lungs at the surface. They had two pairs of muscular fins and could have pulled themselves through the mud if their lakes evaporated and became too shallow to swim in. The fish were cold-blooded—their temperature rose and fell along with that of their surroundings.

Around 370 million years ago some descendants, known as amphibians, had sprawling limbs in place of fins. These cold-blooded animals walked like squirming fish and laid jellylike eggs in water. Hatchlings had gills and fins that disappeared as they matured.

Although most amphibians stayed in or near water, at least one small, agile, and scaly group lived continuously on land. Their young avoided the dangerous tadpole stage in the water and hatched fully formed on land. But there the eggs were in danger of drying out. When these animals began to lay eggs enveloped in a protective membrane and a hard or leathery shell, they became, by definition, reptiles.

About 300 million years ago dense, steamy tropical forests rose from certain swamps, while underwater, giant amphibians with huge gaping jaws waited for passing fish. Scurrying over fallen and decaying swamp-mired logs were the first reptiles. These small lizardlike creatures chased insects with rapid dashes and snapping jaws.

Aggressive, agile, and able to survive where no amphibian would venture, reptiles quickly evolved into a variety of scaly forms. From the start two main branches developed.

One branch, the synapsids, led by the pelycosaurs, developed a larger body size and larger jaws, which enabled them to eat larger prey such as other vertebrates. They and their descendants, the therapsids, dominated the scene for the next 50 million years. Some of these were the ancestors of all mammals.

The second main branch, the sauropsids, for the most part remained small and obscure lizardlike insect eaters while the pelycosaurs and therapsids reigned. Ultimately from among this second group emerged the lizards and their descendants, the snakes. As other sauropsids ventured into the earth's many different environments, some became fish-eating marine reptiles, some the plant-eating

armored pareiasaurs, some the hard-shelled turtles, and some the long-legged archosaurs, or "ruling reptiles."

The Mesozoic Era, or Age of Reptiles, began about 245 million years ago with a catastrophe that cleared the earth of 95 percent of all the species that were living at the time. From among the few reptiles that survived, the archosaurs arose, ultimately to become the dominant animals on land. They had long jaws and big hind legs that made them well-suited for chasing prey. With a long tail acting as a counterbalance, some ran on their hind legs, which freed up their hands for grasping. From the early archosaurs arose the crocodiles, flying pterosaurs, and the most famous of all the prehistoric reptiles, the dinosaurs, or "terrible reptiles."

Like their ancestors, the amphibians, early reptiles had legs that swung out to the sides. They walked like fish out of water, with their undulating backbone doing most of the work. In contrast, dinosaurs had stiffened backbones and erect legs. Their limbs moved only forward and back beneath their bodies. More agile than any of their ancestors or contemporaries, they could probably run farther without tiring. Their legs acted like columns, able to support great weight with little strain.

Dinosaurs originated as small, two-legged, birdlike meat eaters, but rather quickly some turned to eating plants, became larger, and started walking on all fours again. Eventually there were many more plant eaters than predators. Birds arose from small meat-eating dinosaurs with long fingers and elaborate scales that became feathers.

Birds and mammals are "warm-blooded" in that they can create heat within their own bodies. Living reptiles are "cold-blooded" and are unable to do so. Since birds are warm-blooded and crocodiles (related to birds by way of early archosaurs) are not, when did the change take place? Were birdlike dinosaurs warm-blooded? Were *all* dinosaurs warm-blooded? This matter intrigues scientists today. But until a dinosaur has its temperature taken, the argument is not likely to be settled.

Dinosaurs are famous for having become extinct at the close of the Cretaceous Period, 66 million years ago. Actually they seem to have been in decline before then, with only a few species surviving until the very end. Extinction is a continuous process, and mass extinctions have occurred many times, according to the fossil record.

No one knows exactly what killed the last of the dinosaurs. One theory suggests that weather changes were responsible. At the beginning of the Mesozoic Era, when dinosaurs first arose, the continents were joined together into a supercontinent known as Pangaea ("all land"). Vast shallow inland seas and continental shelves moderated temperatures worldwide. As the Mesozoic Era went on, the continents drifted apart again, creating, among other things, the Atlantic Ocean. Changing currents and sea levels made the world's climate less stable. Ultimately half of all animal life, including all of the remaining dinosaurs, pterosaurs, and many forms of marine life, died out, unable to survive in their changing world.

Just as it began, the Mesozoic Era ended with a bang. The evidence suggests that one or more meteorites, several miles wide, hurtled toward the earth and exploded on impact, throwing millions of tons of dust into the atmosphere. This dust would have kept much of the sun's light from reaching the surface. Without enough light many plants would have withered. Without enough plants the giant plant eaters would have died, followed shortly by the giant meat eaters that preyed on them. Perhaps this visitor from space was the final blow that put an end to the reign of dinosaurs that had lasted 150 million years.

Not every reptile was killed during that catastrophe. Crocodiles, turtles, snakes, and lizards survived throughout the Cenozoic Era, or Age of Mammals, some growing as large or larger than their ancestors had during the previous age.

Mammals, birds, fish, and amphibians also survived. Mammals in particular flourished and became the dominant animals on earth. Today some mammals are advanced enough to build moon rockets. Others, such as the platypus and echidna, still lay eggs like reptiles.

Dinosaurs also left living descendants—birds. When you see a roadrunner, think of *Compsognathus* (page 30). When you see an ostrich, think of *Dromiceiomimus* (page 56). And when you eat chicken, pretend it's *Tyrannosaurus* (page 59).

In This Book

Of necessity, the largest creatures have been placed on the gatefold pages, and the others generally follow their proper chronological order, period by period. But some of the animals pictured together were not exact contemporaries of one another in place or time.

All the reptiles illustrated in this book are drawn to the same scale (1 inch = 22½ inches). This makes it easy to compare them with one another and with the 5-foot-tall young people included on every spread. Of course, no humans existed when any of these creatures lived. If you hold this book 18 inches from your eyes, the illustrations will seem the same size as the actual animals would when seen from a distance of about 34 feet.

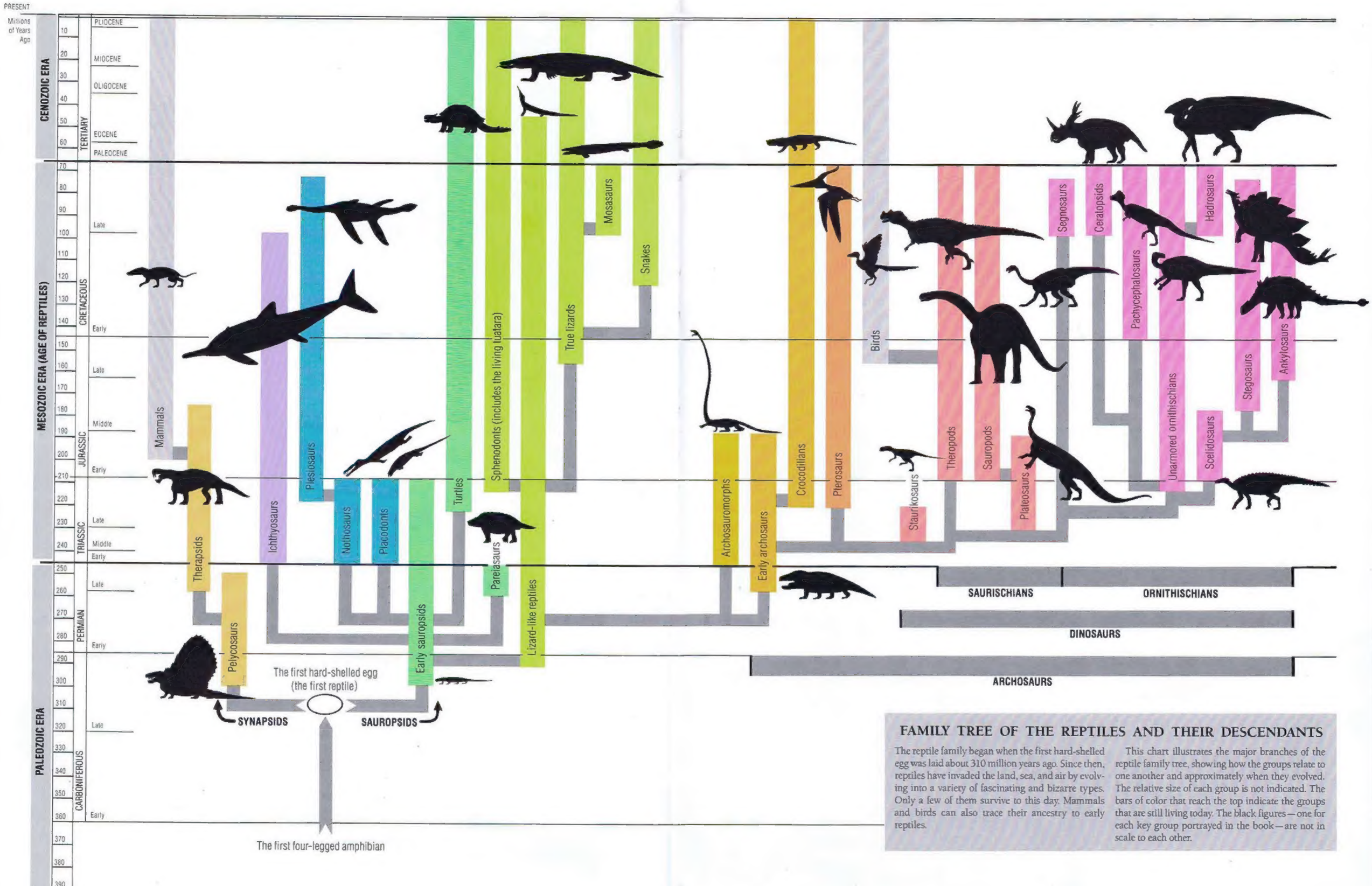
Since almost nothing is known about the coloring of prehistoric reptiles, the patterns and colors illustrated here are guesses. Most living reptiles are rather drab and inconspicuous. But most living birds are richly colored and perhaps their ancestors, the dinosaurs, were too.

The key facts about each animal in this book are summarized in the heading for its text entry, beginning with its scientific name, the pronunciation, and the meaning. *Saurus*, the Greek word for "lizard," is translated as "reptile" whenever the animal is not a true lizard.

The next line contains a list of the scientific categories into which scientists have traditionally grouped each animal in the class *Reptilia*, on the basis of shared characteristics. The list begins with the broadest category (here, usually the subclass or superorder) and ends with a category of closely related animals (here, usually suborder or family). All of the animals that belong to a category share certain features of the skeleton; the closer the relationship, the more the animals have in common. There is much uncertainty and disagreement in the scientific classification of early reptiles, so not all categories are given for every animal. The term *Dinosauria* is not part of the traditional listing, but has been included here before the two orders of dinosaurs, *Saurischia* and *Ornithischia*, because it is so familiar. Also nontraditional, in the entry for the bird-dinosaur *Archaeopteryx*, is the listing of *Aves* (birds) as an order of archosaurs rather than as a separate class.

The next line in the heading contains the period of time in which the animal lived and the location of its fossil find(s), followed by the length of the animal's fossil skeleton. In the case of flyers, the wingspread is given. "Est." means the length is estimated from partial remains. "Up to" means that many species are known, but only the largest is listed.

Currently some scientists prefer to call early reptiles "amniotes," a name that refers to the amniotic membrane, the protective tissue that develops around the embryo and yolk of all living reptiles, birds, and mammals. Instead of speaking of two branches of reptiles, they speak of two branches of amniotes: the synapsids, which include the ancestors of mammals and their kin, and the sauropsids, which include reptiles (snakes, lizards, dinosaurs, etc.) and birds. In this book, however, the term "reptile" will still be used for the early creatures in both the synapsid and sauropsid lines.



FAMILY TREE OF THE REPTILES AND THEIR DESCENDANTS

The reptile family began when the first hard-shelled egg was laid about 310 million years ago. Since then, reptiles have invaded the land, sea, and air by evolving into a variety of fascinating and bizarre types. Only a few of them survive to this day. Mammals and birds can also trace their ancestry to early reptiles.

This chart illustrates the major branches of the reptile family tree, showing how the groups relate to one another and approximately when they evolved. The relative size of each group is not indicated. The bars of color that reach the top indicate the groups that are still living today. The black figures—one for each key group portrayed in the book—are not in scale to each other.

Hylonomus

(hie-luh-NOE-muss) "wood dweller"
Sauropsida • Captorhinida • Captorhinomorpha
Late Carboniferous • Nova Scotia • 1 foot long

Hylonomus was one of the earliest and most primitive of the reptiles. Its fossilized bones were found within the remains of a 300-million-year-old hollow tree fern stump.

The ancestors of reptiles were lizardlike amphibians, four-legged vertebrates that were probably scaly and laid jellylike eggs. Whichever one of them first began laying eggs enveloped in a protective membrane and a hard or leathery shell became the world's first reptile.

We do not know what kind of eggs *Hylonomus* laid. Nevertheless, certain features of its skeleton separate it from the lizardlike amphibians living at the same time. *Hylonomus* had a stronger backbone and more slender limb bones than its contemporaries. It was built for clambering over obstacles such as rocks and tree limbs, and seems to have been a more active hunting animal with better coordination. Instead of passively waiting for its victims to crawl or fly by, *Hylonomus* probably scampered after them in active pursuit. Although able to swim, it most likely remained primarily on dry land, where it was safer.

Most amphibians of the Late Carboniferous were probably as vocal as modern bullfrogs and spring peepers, but *Hylonomus* may have been silent. It seems to have lost the large eardrums that were so prominent above the jaw joint in its amphibian ancestors. Without these, *Hylonomus* was likely deaf to most sounds. As in all early reptiles, this area was filled in with bone and jaw muscles, giving *Hylonomus* a quicker bite for subduing insects and crawling invertebrates such as worms.

Early fish and amphibians had a double row of teeth: a row of many small ones along the margins of the jaws, and a row of a few large fangs descending from the roof of the mouth or palate. No reptile had these large palate fangs, although most, including *Hylonomus*, had smaller teeth hanging over their throat.

Archaeothyris

(ar-key-o-THIE-riss) "ancient opening"
Synapsida • Pelycosauria • Ophiacodontidae
Late Carboniferous • Nova Scotia • 2 feet long

Archaeothyris's name refers to the synapsid opening, an opening in its skull above the jaw joint. This hole identifies it as a synapsid, the branch of reptiles from which all mammals, including humans, evolved. In humans this same synapsid opening remains as the space between the skull and the cheekbone. This opening gave *Archaeothyris* an early advantage, providing space for stronger jaw muscles.

Scaly, sprawling, lizardlike *Archaeothyris* was a contemporary of *Hylonomus* but grew to twice its size. Proportionally *Archaeothyris* had a larger head. Its bite was stronger but not quite as rapid. Perhaps *Archaeothyris* preferred larger prey than insects and dipped back into the swamp to find its food. *Archaeothyris*'s teeth came in a variety of sizes and were larger than those of insect-eating reptiles. The largest were stabbing canines that could have pierced the extra-thick bony scales of early fish, amphibians, and reptiles.

Like living lizards and snakes, no primitive reptiles had separate cavities for the mouth and nasal passages. The nasal passages entered the mouth directly behind the front teeth. A mouthful of food could have blocked the path of air to the lungs. *Archaeothyris*, however, had a high, narrow snout that provided a clear air passage over whatever was in its mouth.

Primitive reptiles, like all living reptiles, were cold-blooded. After a long, cool night, *Archaeothyris* would have had to sun itself until its body temperature warmed up. Horny scales prevented its skin from drying out in the heat.

All primitive reptiles and amphibians had a long, heavy tail as a counterweight to the body, making the backbone arch so that the belly could be lifted off the ground while walking.

Dimetrodon

(die-ME-truh-don) "two-measure tooth"
Pelycosauria • Sphenacodontidae
Early Permian • Texas • up to 14 feet long (est.)

The earliest synapsids were the pelycosaurs, named for their bowl-shaped hips. The largest of the meat-eating pelycosaurs was *Dimetrodon*, the chief predator of its time. Its teeth were large and sharp, like knives. Its jaws were built to withstand the stresses of tearing off large chunks of flesh. The easy curve in its jawline gave this meat eater a natural grin. Living near water in an equatorial region visited by seasonal rains, *Dimetrodon* was one of the most common of all pelycosaurs.

As a cold-blooded reptile, *Dimetrodon* probably had a rather lazy, slow-motion lifestyle punctuated by rapid charges toward its prey. Living reptiles spend a great deal of time sunning themselves, and *Dimetrodon* was better equipped for this than any other reptile. Along its back stretched a sail of skin supported by long spines of bone arising from each of its vertebrae. This sail probably collected the rising sun's heat so well that *Dimetrodon* was able to warm up faster and get an earlier start than its sailless prey. *Dimetrodon* could avoid overheating in the midafternoon sun simply by moving into the shade to let its sail cool off.

Edaphosaurus

(ee-daf-o-SOR-uss) "base reptile"
Pelycosauria • Edaphosauria
Early Permian • Texas • up to 11 feet long

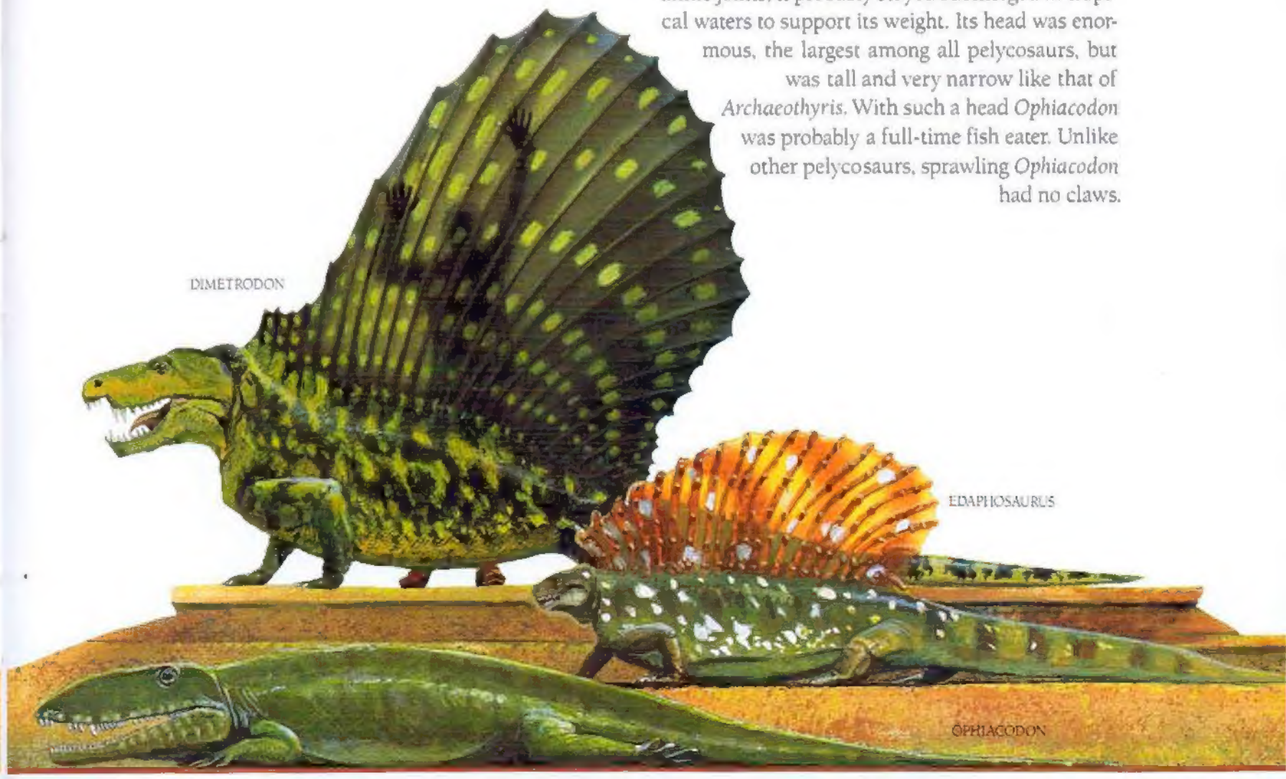
Edaphosaurus's teeth along the edge of its jaws were short, blunt, and all the same size. Similar teeth covered the roof of its mouth and the inner surfaces of its lower jaw. Such teeth show it ate soft plants. *Edaphosaurus* had a small but broad head, a large, rotund body, and short, stout, sprawling limbs. Plant eaters need a big belly because pound for pound, plants are less nutritious than meat, and plant eaters therefore need to eat more. Plants are also harder to digest. They stay in the belly longer because they have to ferment before digestion can take place.

Edaphosaur fin spines resembled the masts of a clipper ship, because they were decorated with many small crossbars. Perhaps these protected the sail tissue from damage.

Ophiacodon

(o-fee-AK-uh-don) "snake tooth"
Pelycosauria • Ophiacodontidae
Late Carboniferous to Early Permian • New Mexico
up to 13 feet long

Ophiacodonts were the earliest pelycosaurs and the largest of these was *Ophiacodon* itself. Having weak ankle joints, it probably stayed submerged in tropical waters to support its weight. Its head was enormous, the largest among all pelycosaurs, but was tall and very narrow like that of *Archaeothyris*. With such a head *Ophiacodon* was probably a full-time fish eater. Unlike other pelycosaurs, sprawling *Ophiacodon* had no claws.



Cotylorhynchus

(kot-ee-lae-RIN-kuss) "cup nose"
Pelycosauria • Caseidae
Late Permian • Oklahoma • up to 13 feet long

Very few pelycosaurs survived into the Late Permian Period, but among those that did was tubby *Cotylorhynchus*. Perhaps its lack of a fin and its huge bulk of 620-plus pounds helped it retain body heat better than other pelycosaurs, which were suffering through cooler night temperatures while equatorial Oklahoma became increasingly arid. This blimplike plant eater was a member of the caseid family, the most diverse and widespread of the plant-eating pelycosaurs.

Huge *Cotylorhynchus* had a tiny head no bigger than that of its much smaller ancestors. As the caseids evolved, the head seems to have stayed the same size while the rest of the body ballooned. The nostrils, eyes, and brain, however, grew in proportion to the rest of the body, so they look extra-large in the tiny skull.

The long, blunt teeth of *Cotylorhynchus* were largest in front, decreasing toward the rear. The animal's front feet were larger than the rear feet and both sets were armed with the largest claws among pelycosaurs. Together these features suggest that *Cotylorhynchus* dug for roots.

Cotylorhynchus's spacious rib cage was twice as wide as it was high to enclose an extremely large gut. Burdened so, the animal must have moved as slowly as a giant turtle, but without the benefit of a shell for defense and support. Defenseless animals can survive only in the absence of predators, and with *Cotylorhynchus* this seems to have been the case. *Cotylorhynchus* often suffered from fractured ribs. Whether they cracked during fights or under the strain of its own resting bulk is not known.

Inostrancevia

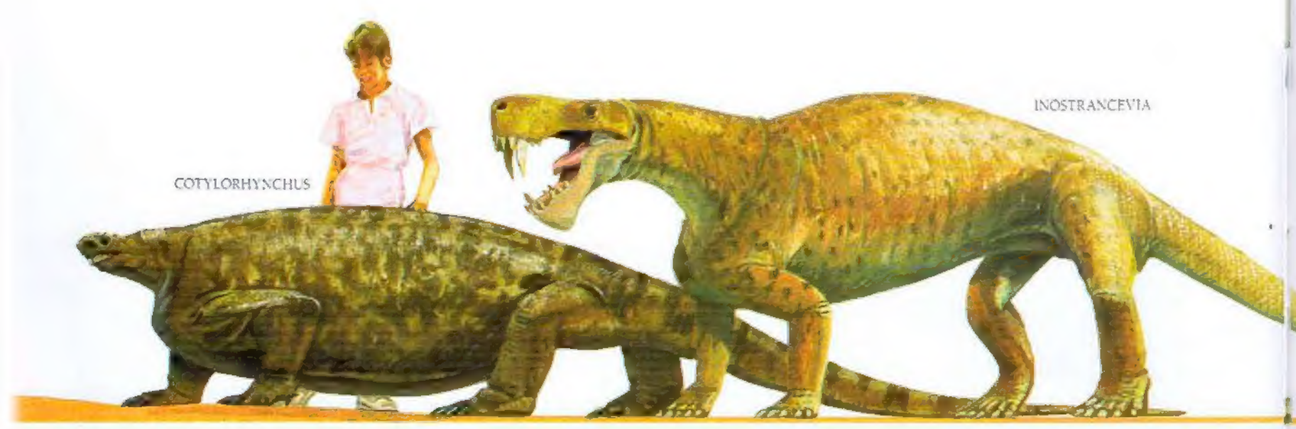
(in-os-tran-SEV-ee-ah) [after Russian paleontologist Aleksandr Inostrancev]
Therapsida • Gorgonopsia • Gorgonopsidae
Late Permian • Russia • 14 feet long

Just as the pelycosaurs were disappearing in what is now Europe and North America, their relatives, the therapsids, were appearing in Russia and South Africa. Therapsids descended from a sail-less relative of *Dimetrodon* (page 13).

Saber-toothed *Inostrancevia* was one of the largest of the meat-eating therapsids. With a head 2 feet long and fanglike canine teeth rivaling those of the dinosaur *Tyrannosaurus* (page 59), *Inostrancevia* was probably the chief predator of its day. Large jaw muscles drove those fangs deep into the flesh of its victims. Its prey would have included the likes of *Keratocephalus* and *Scutosaurus* (facing page).

Therapsid limbs, like those of living crocodilians, could vary between sprawling and semi-erect (think of a half-push-up). Although the elbows and knees still stuck out from the body, the feet were planted directly beneath these joints, not out beyond them as in pelycosaurs and lizards. This improvement meant that *Inostrancevia* kept its belly clear of the ground and could travel longer distances without tiring. The muscle tension used to maintain this posture generated heat, which raised *Inostrancevia*'s metabolism closer to warm-bloodedness. *Dimetrodon* warmed up only when the sun was out, but *Inostrancevia* could create at least some internal heat using its own muscles. In effect, it had a self-starting engine.

Like most therapsids, *Inostrancevia* had a shorter tail than any pelycosaur. Since its legs raised its belly off the ground, a heavy counterbalancing tail was no longer necessary.



Keratocephalus

(ker-ah-toe-SEF-uh-luss) "horn-headed"
Therapsida • Dinocephalia • Tapinocephalidae
Late Permian • South Africa • 10 feet long

About 250 million years before people imagined the unicorn, herds of a hippolike version of that fabled creature roamed the warm plains of the supercontinent of Pangaea on the Antarctic Circle. *Keratocephalus* had a short, stout, bony horn in the middle of its forehead. It was one of the dinocephalians (the "terrible-headed" ones), therapsids with notably thick skulls often topped by horns. *Keratocephalus* probably butted its head against rivals for mates or territory and also used its horn against predators.

Keratocephalus was a large, robust plant eater with a huge gut. Each upper front tooth had a step on its inner surface that provided a crushing table for the lower teeth to work against. The canine teeth were small and indistinguishable from the rest, unlike those of all other therapsids.

Estemmenosuchus

(eh-stem-men-uh-SOOK-uss)
"wreathed with a crown crocodile"
Therapsida • Dinocephalia • Titanosuchia
Late Permian • Russia • 7 feet long

With horns protruding in every direction, *Estemmenosuchus* had one of the most bizarre faces of all dinocephalians (see cover illustration). It probably used its bony head to push rivals away and charge at enemies. Its huge front teeth may have served the same purpose as those of a hippopotamus: to dredge up vast quantities of soft plants from shallow waters.

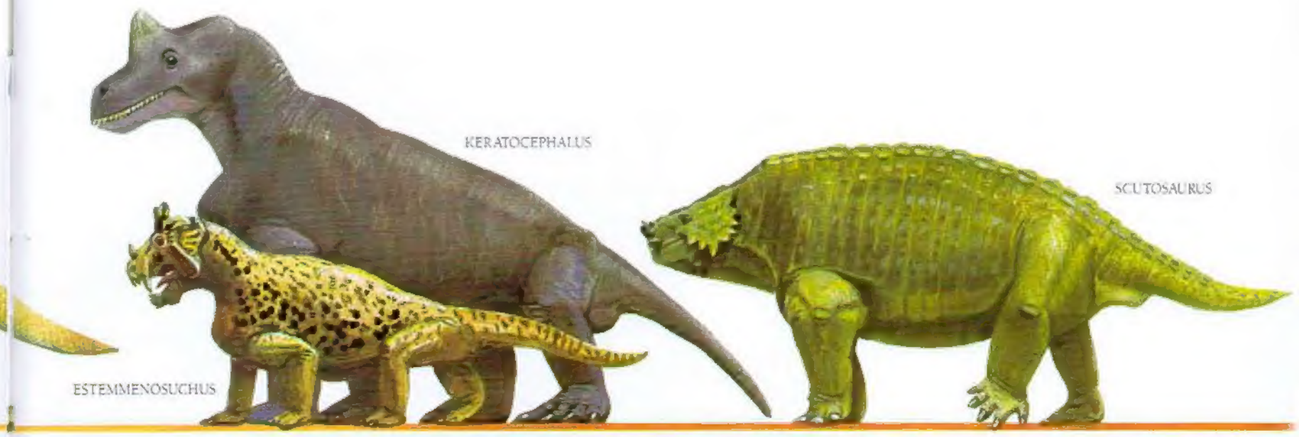
Scutosaurus

(SKEW-toe-sor-uss) "plated reptile"
Sauropsida • Pareiasauroidea • Pareiasauridae
Late Permian • Russia • 8 feet long

Scutosaurus was one of the largest pareiasaurs, bulky plant eaters that appeared only during the Late Permian. We don't know which reptiles were most closely related to them.

Scutosaurus had nearly erect hindquarters, yet its elbows continued to stick out to the sides. This rotund reptile defended itself against the attacks of predators with armor composed of numerous bony plates, known as scutes, embedded in the skin of its back. Today's crocodiles are likewise armored. *Scutosaurus* had a small, flat skull grotesquely ornamented and protected with wide, bumpy cheek plates. These grew so large that *Scutosaurus*'s eardrums faced the rear. Long, bony knobs decorated and protected the lower jaws as well.

This plant eater's teeth were shaped like coarsely serrated leaves on thick-stalked roots. They resembled the teeth of some living plant-eating lizards and many plant-eating dinosaurs. Multi-pointed teeth helped *Scutosaurus* shred vegetation so it could be digested faster.



Cynognathus

(sye-nog-NATH-uss) "dog jaw"
Therapsida • Cynodontia • Cynognathoidea
Early Triassic • South America, South Africa • 7 feet long

Cynodonts were the only predatory therapsids to survive the major extinction marking the end of the Permian Period. One of the largest of these was *Cynognathus*, an aggressive upland hunter. Its skull had both reptilian and mammalian features. Its brain was small, as in early reptiles, but its cheeks were wide-flaring, as in mammals. New jaw muscles that made chewing possible originated from these cheekbones. Most vertebrates swallow food whole. By chewing, *Cynognathus* could break down its food quicker and so hasten digestion and speed up its metabolism.

Like a mammal, *Cynognathus* had three kinds of teeth: nipping incisors, large stabbing canines, and multicusped cheek teeth for chewing. It also had a secondary palate, a shelf of bone that separated the nasal cavity from the mouth cavity, allowing *Cynognathus* to continue breathing even while chewing. Reptiles have three lower jawbones on each side, mammals only one. *Cynognathus* had three, but one was very large and mammal-like. It was only loosely connected to the other two tiny ones. These tiny bones served as hearing organs, as in mammals. One framed its eardrum.

Stahleckeria

(stah-leh-ker-REE-ah) [after Dr. R. Stahlecker]
Therapsida • Dicynodontia • Pristerodontia
Late Triassic • South America • 11 feet long

Stahleckeria was the largest of the dicynodonts, rotund, toothless therapsids with turtlelike beaks and enormous jaw muscles. These common plant eaters slid their jaws back and forth, rolling and crushing each wad of vegetation against the roof of their mouth. As plant-eating therapsids, dicynodonts were only distantly related to the cynodont branch leading toward the mammals.

Stahleckeria's beak was broader than that of other dicynodonts, and unlike others it had no tusks. A unique flat shield of bone at the rear of its skull protected its neck from attack.

Ancestors of Mammals

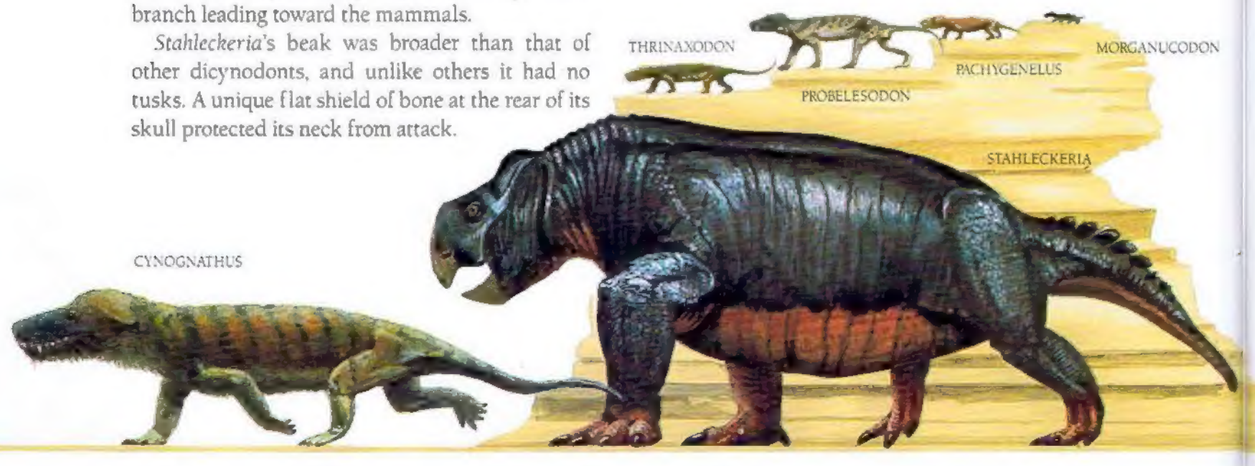
Increasingly mammalian cynodonts diminished in size through time, probably to avoid being seen and eaten by newly arriving archosaurs (page 18).

Twenty-inch-long *Thrinaxodon* of South Africa and Antarctica was one of the earliest cynodonts, living during the earliest part of the Triassic. Hair may have grown from between its scales. Tiny holes in *Thrinaxodon*'s snout allowed large blood vessels and nerves to pass through, probably to nourish and control sensitive whiskers (a type of hair). This clue suggests the presence of ordinary body hair as well.

Probelesodon, a 30-inch-long cynodont, lived during the Middle Triassic in South America. Its backbone undulated less than that of most therapsids and its hind legs were more erect.

Foot-long *Pachygenelus*, from the Late Triassic of Arizona and South Africa, was a weasel-like cynodont with teeth composed of superhard enamel. A mammal's adult teeth must be hard enough to last a lifetime, unlike those of a reptile, which are constantly being shed and replaced with new ones.

Less than 6 inches long, *Morganucodon* from the Early Jurassic of China and England was one of the earliest known mammals. It had a larger brain along with a more sensitive nose and ears than its cynodont ancestors. It may have looked like a fur-covered shrew with a scaly tail and without ear flaps. Still, it continued to lay eggs, as do the most primitive of today's mammals, the platypus and echidna. Unlike any reptile up to that time, its teeth were replaced only once, except the molars, which appeared only in adults and were never lost. All living animals with this pattern of tooth replacement are toothless as infants. If the infant *Morganucodon* was hatched without teeth, it could have found its only nourishment in milk from its mother, and only mammals produce milk.



Tanystropheus

(tan-ee-STROE-fee-uss) "long vertebrae"
Archosauromorpha • Protorosauria • Tanystropheidae
Middle Triassic • Switzerland • up to 35 feet long

In the Triassic Period, while some synapsids evolved toward mammals, the second main branch of reptiles, the sauropsids, developed into a wide variety of ever-larger types.

Tanystropheus was an extraordinarily proportioned sprawling protorosaur with a neck half as long as its entire body. Even hatchlings had extremely long necks. Any animal within the reach of this neck was immediately snapped up by *Tanystropheus* with lightning speed. A giraffe has only seven neck bones. *Tanystropheus* had twelve, nine of which were extremely elongated, making the neck rather inflexible. Neck ribs that were as much as five times longer may have served to snap the neck back like a fiberglass fishing rod after each strike.

Two-foot-long juveniles had three-pronged teeth for eating insects. Adults developed sharp, simple spikelike teeth for spearing fish. Adults could have swum at the surface snaring fish below or else parked themselves on the rocky seashore to dip into the surf.

As with many modern lizards, *Tanystropheus* could lose its tail and grow another. One fossil specimen has tail bones showing signs of having regrown and is the earliest known example of this phenomenon.

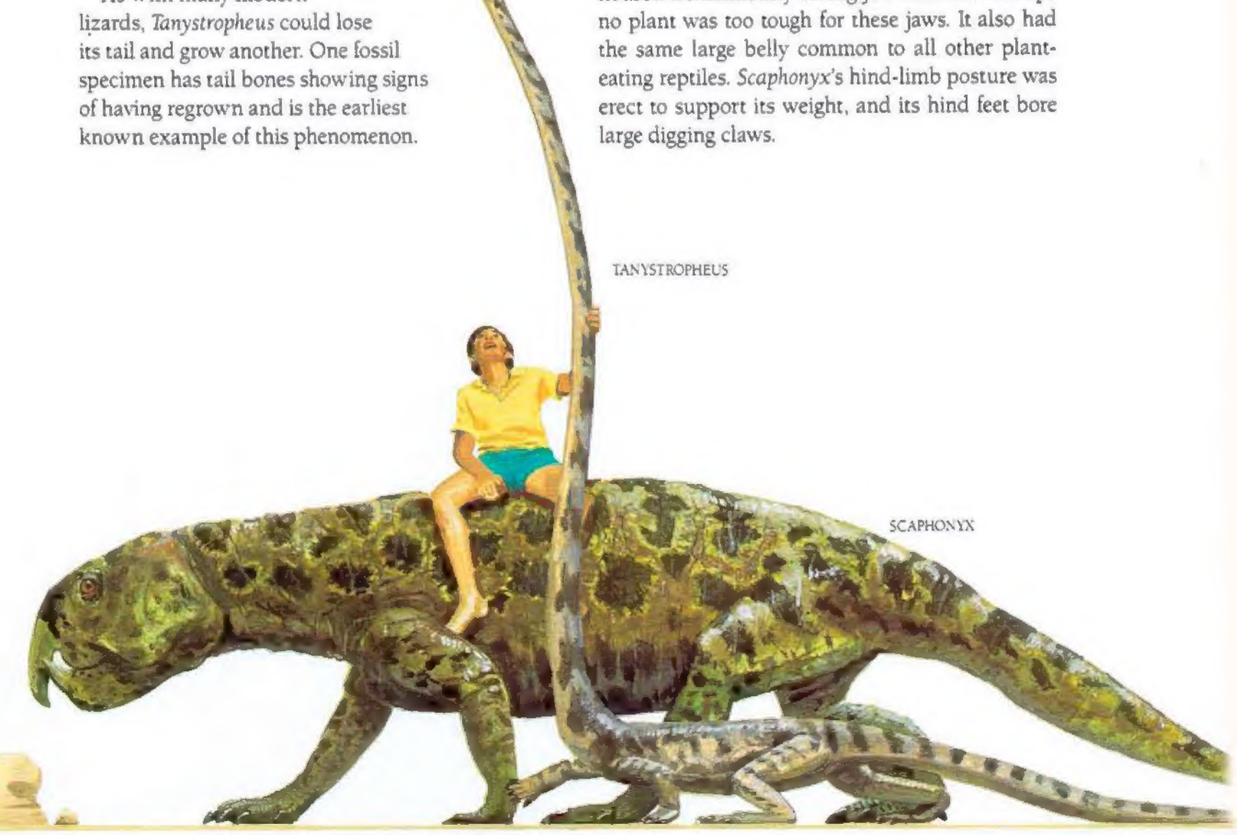
Scaphonyx

(skah-FON-iks) "boat claw"
Archosauromorpha • Rhynchosauria • Rhynchosauridae
Middle Triassic • Brazil, India, Argentina • up to 16 feet long

Scaphonyx was one of the largest and last of the beak-headed rhynchosaurs. Its ancestors resembled primitive sprawling lizards with slightly overhanging upper jaws. In *Scaphonyx* this feature became a pronounced beak unlike that of any other reptile. Two bony beak prongs descended from either side of the nostrils and met each other below the snout. When *Scaphonyx* closed its mouth, this upper beak was pinched in a groove between the twin tips of the lower jaws. In this way the beak could nip off plants or snap twigs and roots in half, like pruning shears.

Scaphonyx also had teeth like no other reptile's. In the upper jaw they were set in numerous rows on special pads divided by a groove. The lower teeth fit precisely into this groove to slice and munch plant material into little pieces. Most reptiles continually shed their old dead teeth and replace them with new ones. In *Scaphonyx*, as in modern rodents, the teeth continued growing as long as the animal lived, wearing flat with use. As the jaw grew, new teeth filled in from the back.

Scaphonyx had an extremely broad head that housed tremendously strong jaw muscles. Perhaps no plant was too tough for these jaws. It also had the same large belly common to all other plant-eating reptiles. *Scaphonyx*'s hind-limb posture was erect to support its weight, and its hind feet bore large digging claws.



Chasmatosaurus

(kaz-mah-toe-SOR-uss) "[skull] opening reptile"
Archosauria • Proterosuchia • Proterosuchidae
Early Triassic • South Africa • 9 feet long

Dinosaurs, pterosaurs (flying reptiles), crocodilians, and their ancestors and kin are collectively known as the archosaurs, a name that means "ruling reptiles." They were, for the most part, large predators that arose from small but long-legged insect-eating ancestors.

One of the earliest known archosaurs was *Chasmatosaurus*. This large, sprawling swamp dweller had a large but lightweight head and long jaws lined with sharp teeth. Its upper jaw was hook-shaped, perhaps to rip chunks of flesh from its victims, or it could have had some special use in catching fish. Small dicynodonts (page 16) shared its swamp and may have served as prey.

In contrast to swamp-dwelling crocodilians, which tuck in their small legs and sweep their broad tail from side to side while swimming, *Chasmatosaurus* probably swam with kicks of its large, sprawling hind legs, especially during the final lunge toward the victim after a successful underwater ambush.

Although the earliest of all reptiles were apparently deaf to most sounds, by the Triassic Period many reptiles, including *Chasmatosaurus*, had fragile sound-conducting ear bones sensitive enough to pick up a broad range of noises.

Erythrosuchus

(eh-rith-roe-SOOK-uss) "crimson crocodile"
Archosauria • Proterosuchia • Erythrosuchidae
Early Triassic • South Africa • 12 feet long

One of the largest four-legged meat eaters in the Early Triassic was the ferocious big-headed *Erythrosuchus*. Like *Chasmatosaurus*, it must have preyed on dicynodonts. The limbs of *Erythrosuchus* were semierect in posture, helping it get about on dry land.

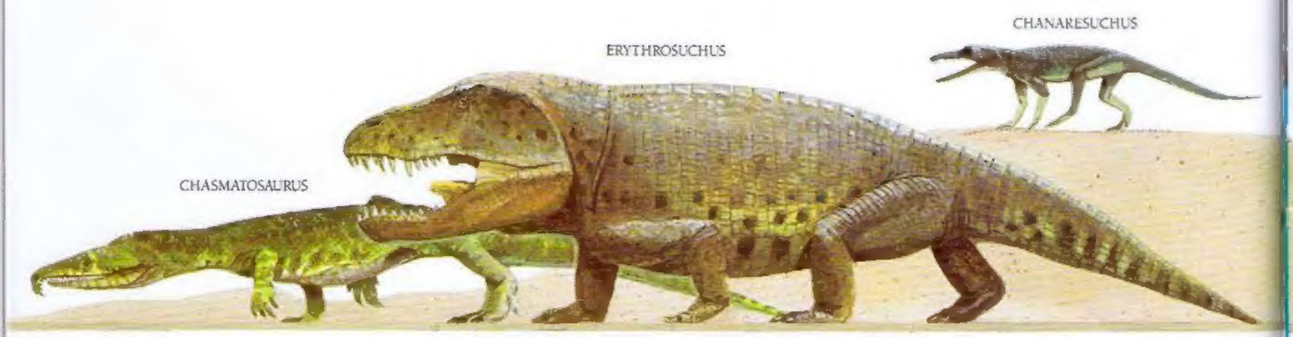
Erythrosuchus had two rows of scutes down the center of its back, a feature of other early archosaurs and crocodilians. Scutes are large scales with bony interiors that develop in the skin. They make a crocodile's back bumpy. Because they are firmly attached to the muscles and bones of the back, scutes help the long backbone support the body when it is held off the ground. Scutes also serve as armor, especially in smaller and younger animals.

A tall, narrow snout is a hallmark of many early archosaurs such as *Erythrosuchus*. This shape helped brace the lightweight jaws against the stresses of large struggling prey.

Chanaresuchus

(cha-nah-ray-SOOK-uss) "Chanares crocodile"
Archosauria • Proterosuchia • Proterochampsidae
Middle Triassic • Argentina • 4 feet long

With relatively long legs and a fairly erect posture, *Chanaresuchus* seems to have been adapted equally well to living both on land and in water. It lived near a large lake filled by seasonal rainfall that was a popular watering hole for many other types of reptiles. *Chanaresuchus*'s head was low and flat, with a long, narrow snout like that of a crocodile. Perhaps this early archosaur fished in the lake, then moved to higher ground to sun itself.



Desmatosuchus

(dez-ma-toe-SOOK-uss) "link crocodile"
Archosauria • Aetosauria • Stagonolepididae
Late Triassic • Arizona, Texas • 11 feet long

Aetosaurs were heavily armored early archosaurs that ate plants. *Desmatosuchus* was one of the largest of these, and it featured a fully erect stance. Its elbows and knees were tucked in at the sides, and its legs moved only in a forward-and-back arc. In addition to the heavy bony plates called scutes that covered its belly, back, and tail, *Desmatosuchus* had a lethal set of large, curved spikes just above its shoulders. Predators would have had a hard time getting through that tough hide, and would have been hurt by those spikes had they tried. Like other aetosaurs, *Desmatosuchus* had a bony, upturned, piglike snout that could have been used to uproot vegetation. It roamed in and around the dense stands of giant trees that would someday become the Petrified Forest.

Machaeroprosopus

(ma-kee-roe-PROS-uh-pus) "[snout like a] knife edge"
Archosauria • Phytosauria • Phytosauridae
Late Triassic • Arizona • 19 feet long

Machaeroprosopus was a phytosaur, an unfortunate misnomer that means "plant reptile." Phytosaurs did not eat plants. They looked like, and probably behaved like, living crocodiles, their distant relatives.

Like a crocodile, *Machaeroprosopus* could skulk along the surface of swamp waters and rivers, giving the appearance of a floating log, perhaps with just its nostrils and eyes poking above the water. The nostrils were not at the tip of its snout, as in crocodilians. Instead they were in a crest near the eyes. *Machaeroprosopus* was one of the largest phytosaurs. In contrast to most others, its teeth came in a variety of lengths, a feature that might have enabled it to more easily grab four-legged prey that came to the water's edge for a drink.

Proganochelys

(proe-gan-uh-KEL-eez) "before brightness turtle"
Testudinata • Chelonia • Proganochelydia
Late Triassic • Germany • 3 feet long

The secret of the turtle's success is its shell, which has provided protection from all sorts of predators throughout the ages. The earliest known turtle was *Proganochelys*, which had a shell much like that of any modern turtle. We know of no turtle ancestors that show us how this unusual mobile shelter made of bone and scales might have evolved.

Unlike most modern turtles, *Proganochelys* did not have the ability to withdraw its neck and tail beneath its shell. Instead, bony spikes protected these vulnerable areas. Along the edges of the shell additional sharp, bony plates, not found in modern turtles, protected its flanks.

Proganochelys was no doubt a slow-moving, rather passive plant and worm eater. Like all turtles, it may have been a good swimmer, too. In the water a variety of soft, slow-moving food was available. *Proganochelys* was one of the few turtles that had teeth, and these were only in the roof of its mouth. Along the edge of its jaws was a sharp horny beak that it used to hook and slice food. (See also *Meiolania*, page 61.)

Saurosuchus

(sor-uh-SOOK-uss) "lizard crocodile"
Archosauria • Rauisuchia • Rauisuchidae
Late Triassic • Argentina • 20 feet long

One of the largest of the early archosaurs was *Saurosuchus*. Like others in the rauisuchian family, it was a bloodthirsty meat eater that lived primarily on land. In contrast to related archosaurs, *Saurosuchus* featured less armor, a shorter snout, and curved, serrated teeth designed for slicing through flesh. And it was fast, too. *Saurosuchus* may have been able to move at great speed in short bursts because it could pull its hind limbs fully erect.

The scutes along the back and tail of *Saurosuchus* were each linked by a peg that fit into a socket on the next scute. *Saurosuchus*'s long backbone was partially supported by this chain of scutes.

Postosuchus

(post-uh-SOOK-uss) "[town of] Post [Texas] crocodile"
Archosauria • Rauisuchia • Poposauridae
Late Triassic • Texas • up to 13 feet long

Postosuchus was a ferocious rauisuchian with very small front limbs. It was not the first early archosaur capable of walking on only two legs, but it was one of the largest. *Postosuchus* terrified and dominated America's southwest. Its diet probably included other early archosaurs, dinosaurs, dicynodonts (page 16), and lizards.

Postosuchus and *Saurosuchus* were more closely related to crocodiles, despite their resemblance to dinosaurs. Certain features of their hips and ankles identify them this way. And no dinosaur had a linked double row of armor along the back like these rauisuchians.

Ornithosuchus

(or-nith-uh-SOOK-uss) "bird crocodile"
Archosauria • Ornithosuchia • Ornithosuchidae
Middle to Late Triassic • Scotland • up to 13 feet long

Ornithosuchus was one of the largest members of the family that bears its name. Whenever it snapped its mouth shut, twin fangs from the lower jaws remained wickedly exposed, bulldog fashion, outside a pinched-in section of its snout. With its extra-large knife-edged teeth, *Ornithosuchus* could have slashed a victim till it bled to death. A large, bony flange jutted out in front of each eye, perhaps serving as a canopy to shade it.

Ornithosuchians resembled the rauisuchians in having an erect stance and a predatory lifestyle, but they belonged to a separate line, the one that gave rise to dinosaurs.

Lagosuchus

(lah-go-SOOK-uss) "rabbit crocodile"
Archosauria • Ornithosuchia • Lagosuchidae
Middle Triassic • Argentina • 1 foot long

Lagosuchus is the closest thing we know to a direct ancestor of dinosaurs. Evidence for this comes in part from its ankle joint. In most land reptiles the ankle joint must rotate during the course of each step. In dinosaurs, pterosaurs, and birds, the ankle joint is stronger and simpler, working only in a fore-and-aft direction, like a hinge. Tiny *Lagosuchus* is one of the few other archosaurs known to have had this sort of simplified ankle joint.

Like a bird, *Lagosuchus* had hollow bones and was a graceful, agile sprinter at a lakeside community. It may have preyed upon small, swift lizards, relying on its great speed and agility for defense as well. It had five toes, but like most dinosaurs ran on only the middle three.

Pseudhesperosuchus

(sood-hes-per-uh-SOOK-uss) "false western crocodile"
Archosauria • Crocodilia • Sphenosuchia
Late Triassic • Argentina • 4 feet long

The very first crocodilians were not like the lumbering river ambushers we know today. In other words, not every crocodilian looked like a crocodile. The sphenosuchians were quite slender and agile land rovers, similar to their rauisuchian-like ancestors. *Pseudhesperosuchus* was just such an animal, built along the lines of a speedy greyhound, though not as fast.

Outwardly only the low profile of *Pseudhesperosuchus*'s head suggests its relationship with crocodiles. Its teeth were relatively few and small. Perhaps this was a "land croc" that specialized in raiding the nests of other reptiles, carting off the eggs and young. The slender proportions of its body may have helped *Pseudhesperosuchus* remain cool in the heat and humidity of its rain-soaked tropical jungle home.

Saltoposuchus

(salt-uh-poe-SOOK-uss) "leaping crocodile"
Archosauria • Crocodilia • Sphenosuchia
Late Triassic • Germany • 4 feet long

Saltoposuchus was a sphenosuchian land croc with such tiny forelimbs that it must have walked on its hind limbs alone. According to the fossil record, there were very few two-legged crocodilians. This one may have fed on fast-moving lizards and used its speed to escape from predators. (See other crocodilians on pages 43–45 and 60.)

Eudimorphodon

(you-die-MOR-foe-don) "true two-shaped teeth"
Archosauria • Pterosauria • Rhamphorhynchoidea
Late Triassic • Italy • 4-foot wingspread

Pterosaurs were the only flying archosaurs (other than birds, which evolved later). Pterosaurs looked like tiny sprinting dinosaurs with wings, and with good reason. An archosaur like *Lagosuchus* was their common ancestor. *Eudimorphodon* is one of the earliest known pterosaurs. (See others on pages 35 and 46–47.)

With its teeth of many sizes, *Eudimorphodon* may have plucked fish from surface waters while flying overhead, like a modern skimmer. Like most known pterosaurs, it lived along the shorelines.

Eudimorphodon's forelimbs and especially its fourth finger were elongated to frame a wing. A special skinlike membrane stretched out between its body and its flapping arms. The wing skin was similar to that of a bat, but embedded with numerous hard, flat, but flexible fibers arranged parallel to one another, patterned like a bird's flight feathers. In contrast to bats, *Eudimorphodon*'s legs were not part of the wing and were kept tucked in during flight.

This early pterosaur was similar in many ways to the first bird, *Archaeopteryx* (page 37), though they were on different branches of the archosaur family tree. Both had a stiff, compact body to provide a sturdy base for their flapping wings. Both had a long, thin, stiff tail and walked with their heels elevated. Both had three sharp-clawed fingers in the leading edges of their wings. Both probably evolved from ground-sprinting, rather than tree-climbing, ancestors.

In contrast, no pterosaur had feathers, and the structure of the wing was different. Birds fold their wings at the wrist; *Eudimorphodon* folded its wings at the joint between the palm and the extra-long finger.

Staurikosaurus

(stoe-rik-uh-SOR-uss) "[southern] cross reptile"
Archosauria • Dinosauria • Staurikosauria
Middle Triassic • southernmost Brazil • 7 feet long

One of the very first dinosaurs was *Staurikosaurus*. This bloodthirsty meat eater was a better runner over longer distances than any of its archosaurian ancestors or contemporaries.

A typical reptile hipbone has a depression into which the head of the thighbone fits. Only in dinosaurs has this depression penetrated the bone to form a hole. This feature, and many others, indicates that dinosaur limbs were held vertically, fully beneath the torso, not splayed out. Like columns under a bridge, erect legs made the support of a heavy body possible, and allowed dinosaurs to become giants.

Alert, active, and perhaps warm-blooded, *Staurikosaurus* ran like a bird, with its backbone held horizontally, its large head counterbalanced by a long tail. As in birds, its ankle joint was a simple hinge. Only its toes touched the ground. Its heels were elevated to extend the stride and spring-cushion each step. This body plan made for a swift and agile animal, able to escape giant four-legged meat-eating archosaurs like *Ornithosuchus* (page 20) and pursue smaller archosaurs, cynodonts (page 16), and other reptiles.

Staurikosaurus's basic features were retained by every one of its meat-eating relatives for the next 150 million years. Those relatives that took to eating plants (such as sauropodomorphs, next page) developed big bellies and dropped down to all fours again when they grew bigger.

Coelophysis

(see-loe-FIE-siss) "hollow form"
Archosauria • Dinosauria • Saurischia • Theropoda
Late Triassic • New Mexico, Arizona • 10 feet long

Coelophysis is classified as a saurischian ("reptile-hipped") dinosaur because its pubic bone pointed forward, as in most reptiles (see page 62).

About 210 million years ago dozens of *Coelophysis* were buried together, perhaps as the result of a flash flood that caught the flock by surprise. The abdomen area of some of the fossil skeletons contains young ones that appear too mature to have been embryos. Perhaps they were hatchlings that had been eaten by cannibalistic adults.

Scaly *Coelophysis* was one of the early theropods, the two-legged meat-eating dinosaurs. Lightly built and agile, it had hollow bones (hence its name) like those of a bird. *Coelophysis*'s skull was narrow and its jaws were lined with serrated slashing teeth for making deep gashes in the flesh of its prey. A flock (or pack) could have inflicted dozens of flesh wounds in a large victim, causing it to bleed to death.

Found in warm, humid forests of giant conifers alongside dicynodonts (page 16) and other archosaurs, *Coelophysis* probably ate large and small reptiles of all types, swallowing bite-size pieces without chewing.

Plateosaurus

(plate-ee-uh-SOR-uss) "flat reptile"
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Late Triassic • Europe, South Africa, Nova Scotia • 21 feet long

Plateosaurus was one of the earliest known saurischian plant eaters. A stretched-out body and neck enabled this dinosaur to feed on leaves beyond the reach of other plant eaters. Propped against a tree, *Plateosaurus* was able to stand on its hind legs alone, but fossil footprints indicate that this top-heavy dinosaur moved on all fours.

Plateosaurus had serrated, leaflike teeth and small cheeks to hold its food in while eating. It also swallowed rocks ("gizzard stones") to help pulverize the plant bits. For defense, its four long toes were each armed with a large claw and each hand bore an enormous "thumb" claw.

Melanorosaurus

(mel-ah-nor-uh-SOR-uss) "black mountain reptile"
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Late Triassic—Early Jurassic • South Africa • 36 feet long (est.)

Larger size meant that *Melanorosaurus* could feed even beyond the reach of *Plateosaurus*. Few enemies were large enough to attack an adult, especially within the protection of the herd. Like all dinosaurs, *Melanorosaurus* had a scaly skin.

Fabrosaurus

(fa-broe-SOR-uss) "[Jean Henri] Fabre's reptile"
Archosauria • Dinosauria • Ornithischia • Fabrosauridae
Late Triassic–Early Jurassic • South Africa • 3 feet long

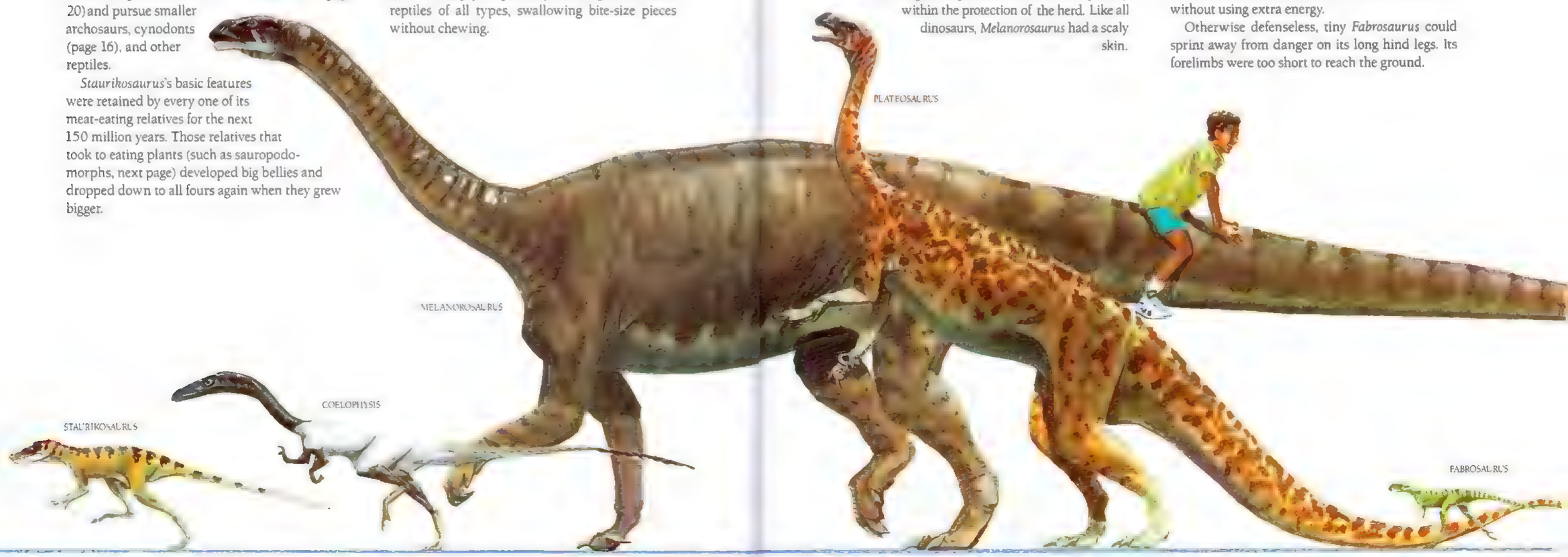
Closely resembling the small early saurischian dinosaurs was the early ornithischian *Fabrosaurus*. Ornithischians were plant-eating dinosaurs with birdlike hipbones and a lower jaw tipped with a beak. Most also had a corset of bone along the vertebrae.

The hipbones of *Fabrosaurus* were unlike those of the "reptile-hipped" saurischians. In ornithischians ("bird hips") the pubic bone pointed backward, creating room in the abdomen for a larger gut (see page 62). Birds have similar hips, but they are not related to ornithischians.

In place of teeth at the tip of its lower jaws, *Fabrosaurus* had a horn-covered beak that it used to snip off fernlike fronds from stumpy cycads. Its cheek teeth were small, weak, and useless for chewing.

Fabrosaurus, like all unarmored ornithischians, had a trellislike grouping of bony splints tying the vertebrae together from the lower back to the tail. This arrangement stiffened and supported the back like a corset, raising the counterbalancing tail without using extra energy.

Otherwise defenseless, tiny *Fabrosaurus* could sprint away from danger on its long hind legs. Its forelimbs were too short to reach the ground.



Utatsusaurus

(oo-tat-soo-SOR-uss) "Utatsu [Japan] reptile"
Ichthyosauria • Utatsusauridae
Early Triassic • Japan • 5 feet long

Ichthyosaurs ("fish reptiles") were reptiles that lived in the open seas like whales and dolphins. *Utatsusaurus* was one of the earliest. Its unknown ancestors must have been four-legged lizardlike land reptiles that found food in the water, much like the marine iguana of today. *Utatsusaurus*'s long, thin tail was not very different from that of a land reptile, but its limbs were transformed into swimming paddles. Inside each paddle were the bones that had once supported five separate fingers. Like a whale, *Utatsusaurus* breathed air, surfacing occasionally to do so, and gave birth to its young at sea.

Utatsusaurus was a fish eater with a short snout, long, thin teeth, and a streamlined body. Its eyes were large to spot its prey. The nostrils were near the eyes, far from the tip of the snout, as in most reptiles. Like other early ichthyosaurs, *Utatsusaurus* lived near the North Pole, suggesting either that the poles must have been much warmer then than they are today or that ichthyosaurs were unusual reptiles that could tolerate the cold.

Shonisaurus

(shone-ee-SOR-uss) "Shoshone [Mountain] reptile"
Ichthyosauria • Shastasauridae
Late Triassic • Nevada • 46 feet long

Shonisaurus was the largest ichthyosaur and one of the largest animals of its day, rivaling many living whales in size. It may have tipped the scales at 80,000 pounds.

This marine giant had long, slender jaws 10 feet in length that, curiously, were armed with only a few small teeth near the tips. Whatever it ate must have been small, soft, slow, and numerous. *Shonisaurus*'s eyes were 12 inches in diameter and ringed with overlapping bones that supported the eyeball to maintain focus and prevent its collapse under water pressure. The body was deep and especially wide at the belly to enclose a cavernous stomach that constantly needed refilling. *Shonisaurus* had huge paddles, and as in all early ichthyosaurs, the front pair was equal in size to the rear pair. The tail supported a small, triangular fin to help push or guide this reptile through the water. (See later ichthyosaurs on page 38.)

UTATSUSAURUS

CYMBOSPONDYLUS

SHONISAURUS

Cymbospondylus

(sim-boe-SPON-dee-luss) "hollow vertebrae"
Ichthyosauria • Shastasauridae
Middle Triassic • Nevada • up to 45 feet long (est.)

Cymbospondylus was the slenderest of the ichthyosaurs. In length some specimens rivaled *Shonisaurus*, though they were less than a fourth as heavy. For its size *Cymbospondylus* had the smallest head of any ichthyosaur, and it was the only one with a neck long enough to be flexible. The jaws of this vicious predator were filled with sharp, spiky teeth, ideal for snaring slippery fish and squidlike creatures.

PLACODUS

HENODUS

Placodus

(PLAK-uh-duss) "plate tooth"
Placodontia • Placodontidae
Middle Triassic • Europe • 9 feet long

Walruslike *Placodus* was one of the placodonts, unusual Triassic marine reptiles with massive flat back teeth set like paving stones in the jaws and palate for crushing the shells of sea mollusks. *Placodus* also had protruding front teeth for plucking mollusks off rocks.

Placodus had a stout body resembling that of other marine reptiles, except that it was armored with a single row of round, bony bumps above the spine. These would not have offered much protection from underwater predators. *Placodus* swam by undulating its long tapered tail and paddling with its small webbed feet. It could have been found either submerged in quiet shallow sea inlets or sunning itself on the nearby shore.

Henodus

(heh-NOE-duss) "one tooth"
Placodontia • Henodontidae
Late Triassic • Europe • 7 feet long

Henodus was a placodont with a shell resembling that of a turtle. But *Henodus*'s shell was broad and flat, and the pattern of its bones and scutes was totally different. *Henodus* had only four teeth, one upper and one lower on each side of its jaws (hence its name). Edging the front of the mouth beneath its squared-off beak were short strainer plates that filtered small crustaceans and plankton out of seawater. *Henodus* was probably a timid creature that buried itself in the sands beneath shallow waters where food was plentiful and air was not far away. Its tiny limbs would not have propelled it quickly through the sea. *Henodus* would have relied on its large tail to do that.

Paranothosaurus

(pair-uh-noe-thuh-SOR-uss) "similar to the false reptile"
Sauropterygia • Nothosauria • Nothosauridae
Middle Triassic • Germany • 13 feet long

Paranothosaurus was one of the largest nothosaurs, "reptilian seals" better adapted to swimming than to hauling themselves out on land. A swift and agile marine reptile, *Paranothosaurus* had a long flexible neck, like all nothosaurs, and long, flat jaws that would have snapped at passing fish faster than the blink of an eye.

Paranothosaurus was an aggressive predator, well adapted to life in the sea. Its limbs were small but had not changed into flippers. Perhaps they were useful in "rowing" through the water. *Paranothosaurus* probably made quick starts and fast changes of direction by rapidly undulating its long flexible body and tail like a crocodile. On rare excursions to land, perhaps to nest or sun itself, *Paranothosaurus* would have pushed itself along, sledding on its belly, because its legs were too small to have hoisted its body off the ground.

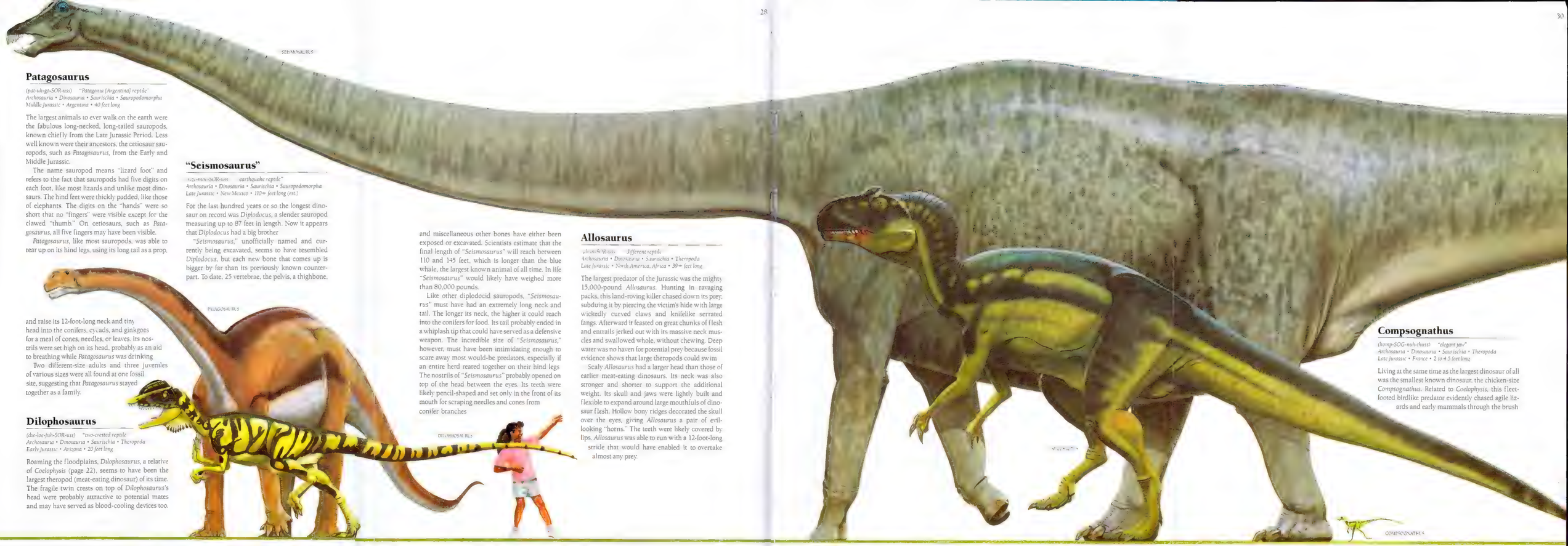
Pistosaurus

(pis-toe-SOR-uss) "liquid reptile"
Sauropterygia • Plesiosauria • Pistosauroidea
Middle Triassic • France • 10 feet long

Pistosaurus was one of the earliest of the plesiosaurs, seagoing nothosaur relatives that swam by flapping their large flipperlike limbs, not by undulating their long torsos and tails. Not very different from a large nothosaur, *Pistosaurus* may have undulated a bit while flapping. *Pistosaurus* was a fish eater that darted its long neck and narrow snout into schools of fish for a meal. Whether it ever ventured on land is not known. (See later plesiosaurs on pages 39–42.)

PARANOTHOSAURUS

PISTOSAURUS



Patagosaurus

(pat-uh-go-SOR-uss) "Patagonia [Argentina] reptile"
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Middle Jurassic • Argentina • 40 feet long

The largest animals to ever walk on the earth were the fabulous long-necked, long-tailed sauropods, known chiefly from the Late Jurassic Period. Less well known were their ancestors, the cetiosaur sauropods, such as *Patagosaurus*, from the Early and Middle Jurassic.

The name sauropod means "lizard foot" and refers to the fact that sauropods had five digits on each foot, like most lizards and unlike most dinosaurs. The hind feet were thickly padded, like those of elephants. The digits on the "hands" were so short that no "fingers" were visible except for the clawed "thumb." On cetiosaurs, such as *Patagosaurus*, all five fingers may have been visible.

Patagosaurus, like most sauropods, was able to rear up on its hind legs, using its long tail as a prop, and raise its 12-foot-long neck and tiny head into the conifers, cycads, and ginkgoes for a meal of cones, needles, or leaves. Its nostrils were set high on its head, probably as an aid to breathing while *Patagosaurus* was drinking.

Two different-size adults and three juveniles of various sizes were all found at one fossil site, suggesting that *Patagosaurus* stayed together as a family.

Dilophosaurus

(die-loe-fuh-SOR-uss) "two-crested reptile
Archosauria • Dinosauria • Saurischia • Theropoda
Early Jurassic • Arizona • 20 feet long

Roaming the floodplains, *Dilophosaurus*, a relative of *Coelophysis* (page 22), seems to have been the largest theropod (meat-eating dinosaur) of its time. The fragile twin crests on top of *Dilophosaurus*'s head were probably attractive to potential mates and may have served as blood-cooling devices too.

"Seismosaurus"

sigh-smo-SOR-uss "earthquake reptile"
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Late Jurassic • New Mexico • 110+ feet long (est.)

For the last hundred years or so the longest dinosaur on record was *Diplodocus*, a slender sauropod measuring up to 87 feet in length. Now it appears that *Diplodocus* had a big brother.

"*Seismosaurus*," unofficially named and currently being excavated, seems to have resembled *Diplodocus*, but each new bone that comes up is bigger by far than its previously known counterpart. To date, 25 vertebrae, the pelvis, a thighbone, and miscellaneous other bones have either been exposed or excavated. Scientists estimate that the final length of "*Seismosaurus*" will reach between 110 and 145 feet, which is longer than the blue whale, the largest known animal of all time. In life "*Seismosaurus*" would likely have weighed more than 80,000 pounds.

Like other diplodocid sauropods, "*Seismosaurus*" must have had an extremely long neck and tail. The longer its neck, the higher it could reach into the conifers for food. Its tail probably ended in a whiplash tip that could have served as a defensive weapon. The incredible size of "*Seismosaurus*," however, must have been intimidating enough to scare away most would-be predators, especially if an entire herd reared together on their hind legs. The nostrils of "*Seismosaurus*" probably opened on top of the head between the eyes. Its teeth were likely pencil-shaped and set only in the front of its mouth for scraping needles and cones from conifer branches.

Allosaurus

al-oh-SOR-uss "different reptile"
Archosauria • Dinosauria • Saurischia • Theropoda
Late Jurassic • North America, Africa • 39+ feet long

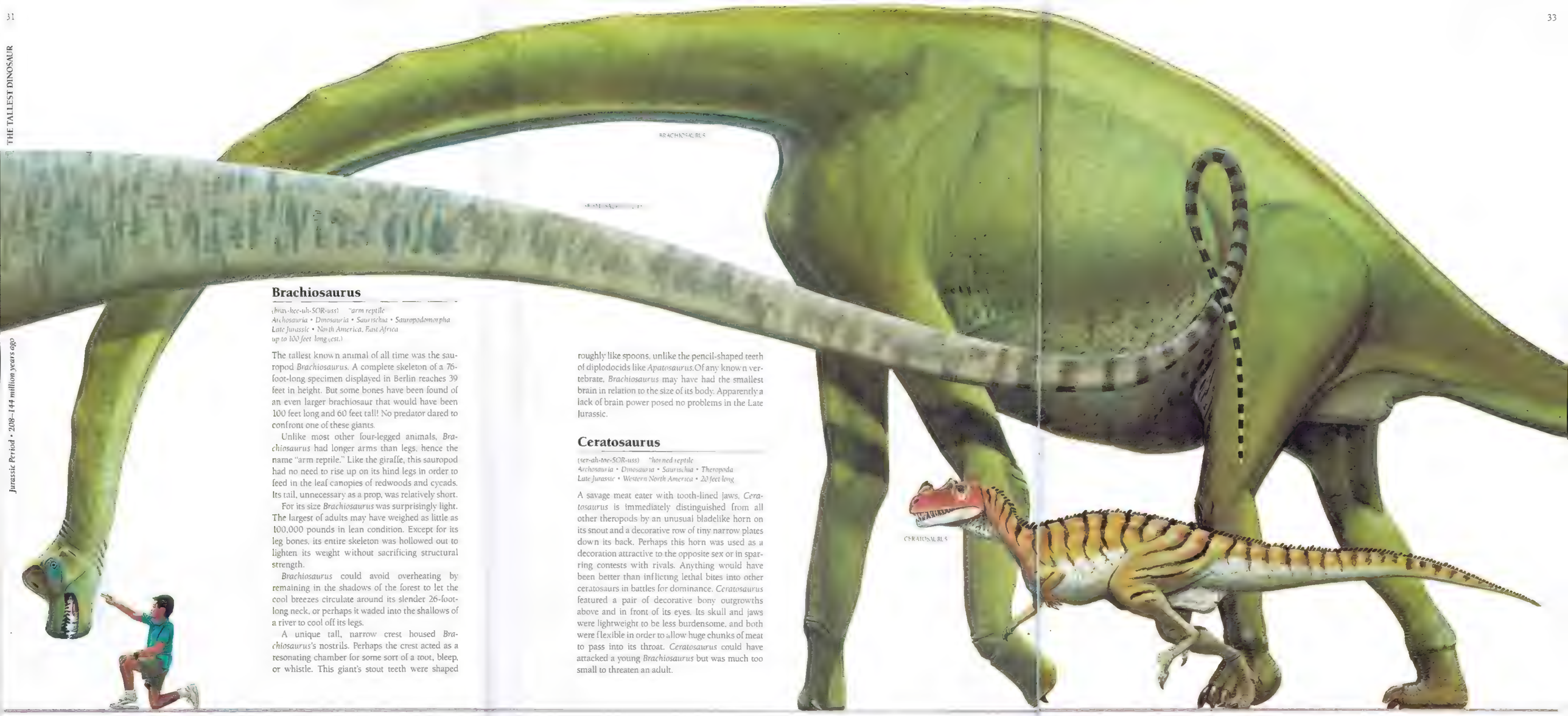
The largest predator of the Jurassic was the mighty 15,000-pound *Allosaurus*. Hunting in ravaging packs, this land-roving killer chased down its prey, subduing it by piercing the victim's hide with large wickedly curved claws and knifelike serrated fangs. Afterward it feasted on great chunks of flesh and entrails jerked out with its massive neck muscles and swallowed whole, without chewing. Deep water was no haven for potential prey because fossil evidence shows that large theropods could swim.

Scaly *Allosaurus* had a larger head than those of earlier meat-eating dinosaurs. Its neck was also stronger and shorter to support the additional weight. Its skull and jaws were lightly built and flexible to expand around large mouthfuls of dinosaur flesh. Hollow bony ridges decorated the skull over the eyes, giving *Allosaurus* a pair of evil-looking "horns." The teeth were likely covered by lips. *Allosaurus* was able to run with a 12-foot-long stride that would have enabled it to overtake almost any prey.

Compsognathus

(komp-SOG-nuh-thuss) "elegant jaw"
Archosauria • Dinosauria • Saurischia • Theropoda
Late Jurassic • France • 2 to 4.5 feet long

Living at the same time as the largest dinosaur of all was the smallest known dinosaur, the chicken-size *Compsognathus*. Related to *Coelophysis*, this fleet-footed birdlike predator evidently chased agile lizards and early mammals through the brush



Brachiosaurus

(brak-kee-uh-SOR-uss) "arm reptile
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Late Jurassic • North America, East Africa
up to 100 feet long (est.)

The tallest known animal of all time was the sauropod *Brachiosaurus*. A complete skeleton of a 76-foot-long specimen displayed in Berlin reaches 39 feet in height. But some bones have been found of an even larger brachiosaur that would have been 100 feet long and 60 feet tall! No predator dared to confront one of these giants.

Unlike most other four-legged animals, *Brachiosaurus* had longer arms than legs, hence the name "arm reptile." Like the giraffe, this sauropod had no need to rise up on its hind legs in order to feed in the leaf canopies of redwoods and cycads. Its tail, unnecessary as a prop, was relatively short.

For its size *Brachiosaurus* was surprisingly light. The largest of adults may have weighed as little as 100,000 pounds in lean condition. Except for its leg bones, its entire skeleton was hollowed out to lighten its weight without sacrificing structural strength.

Brachiosaurus could avoid overheating by remaining in the shadows of the forest to let the cool breezes circulate around its slender 26-foot-long neck, or perhaps it waded into the shallows of a river to cool off its legs.

A unique tall, narrow crest housed *Brachiosaurus*'s nostrils. Perhaps the crest acted as a resonating chamber for some sort of a toot, bleep, or whistle. This giant's stout teeth were shaped roughly like spoons, unlike the pencil-shaped teeth of diplodocids like *Apatosaurus*. Of any known vertebrate, *Brachiosaurus* may have had the smallest brain in relation to the size of its body. Apparently a lack of brain power posed no problems in the Late Jurassic.

Ceratosaurus

(ser-ah-tee-SOR-uss) "horned reptile
Archosauria • Dinosauria • Saurischia • Theropoda
Late Jurassic • Western North America • 20 feet long

A savage meat eater with tooth-lined jaws, *Ceratosaurus* is immediately distinguished from all other theropods by an unusual bladelike horn on its snout and a decorative row of tiny narrow plates down its back. Perhaps this horn was used as a decoration attractive to the opposite sex or in sparring contests with rivals. Anything would have been better than inflicting lethal bites into other ceratosaurs in battles for dominance. *Ceratosaurus* featured a pair of decorative bony outgrowths above and in front of its eyes. Its skull and jaws were lightweight to be less burdensome, and both were flexible in order to allow huge chunks of meat to pass into its throat. *Ceratosaurus* could have attacked a young *Brachiosaurus* but was much too small to threaten an adult.

Apatosaurus

(ah-pat-toe-SOR-uss) "deceptive reptile"
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Late Jurassic • Colorado, Wyoming • up to 75 feet long

Formerly known as *Brontosaurus*, *Apatosaurus* was a giant sauropod weighing in at 60,000 pounds. This dinosaur had shorter arms than legs, its nostrils were on top of its head, and its tail ended in a whiplash tip. It also had a thick neck and a high arch in its backbone.

Apatosaurus was a common plains dweller that lived in family herds that migrated from place to place. Young ones may have found protection in the middle of the herd, as suggested by fossil footprints. Adults, because of their great size, probably had no enemies.

When it found a suitable forest grove, *Apatosaurus* would rear up on its hind legs and raise its small cheekless jaws into the cycad and conifer boughs for a meal, raking in fronds and needles with its pencil-like teeth. It deliberately swallowed rocks to mash the unchewed plant matter to pulp in its gizzard.

Many fossil reptiles are found without their skulls, and *Apatosaurus* was no exception. For many years the wrong head was assigned to its skeleton, but recently the right head was found and put into place.

Dicraeosaurus

(die-kree-uh-SOR-uss) "forked reptile"
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Late Jurassic • East Africa • 40 feet long

Not all sauropods had especially long necks and that of *Dicraeosaurus* was the shortest known, in proportion to the rest of its body. Evidently this dinosaur browsed on much lower-growing vegetation than other sauropods. Its neck vertebrae were deeply forked, hence its name. At the other end, its tail was very long and ended in a whiplash tip.

Dimorphodon

(die-MORF-uh-don) "two-shape teeth"
Archosauria • Pterosauria • Rhamphorhychoidea
Early Jurassic • England • 4-foot wingspread

Dimorphodon is the earliest known of the Jurassic pterosaurs (flying reptiles). It had a body that resembled that of its Triassic relative, *Eudimorphodon* (page 21), but its head was tall and its front teeth were spiky, perhaps to spear fish while on the wing. *Dimorphodon*'s cheek teeth were tiny and numerous, useful for gripping prey while swallowing.

Like the modern big-billed bird the toucan, *Dimorphodon* had an enormous airy snout that may have been equally colorful, perhaps to advertise itself to potential mates. *Dimorphodon*'s legs and front claws were very strong and sturdy. Perhaps it ran after lizards, attacking with tooth and claw, then flew away back to its nest with a meal for its hatchlings.

Dimorphodon, like other pterosaurs, was covered with a hairlike substance for insulation. Insulation helps keep the body at a constant temperature in extreme weather. It is found on warm-blooded animals, so pterosaurs may have been warm-blooded. (See also pages 46–47.)

APATOSAURUS

BRACHIOSAURUS (cont.)

DICRAEOSAURUS

DIMORPHODON

Scelidosaurus

(sel-ee-doe-SOR-uss) "limb reptile"
Archosauria • Dinosauria • Ornithischia • Scelidosauria
Early Jurassic • England • 13 feet long

The early bird-hipped plant eaters (such as *Fabrosaurus*, page 23) had many later relatives that were so large and top-heavy that they had to walk on their hands as well as their feet. Some of these developed an armor of bony plates arising from horny skin tissue, which protected them against the attacks of predators.

One of the earliest of these beaked, armored plant-eating dinosaurs was *Scelidosaurus*, weighing in at close to 1,000 pounds. This scaly dinosaur had rows of enlarged scutes underlaid with low bony studs, as in the ankylosaur *Sauropelta* (page 51). Its feet, legs, and tail remained similar to early ornithischians like *Fabrosaurus*. Its hips and head resembled those of the stegosaur *Stegosaurus* (facing page).

Scelidosaurus probably lived in forests, munching soft ferns while staying alert for danger. It would have run from predators, but if overtaken would have counted on its armor to help it survive.

Kentrosaurus

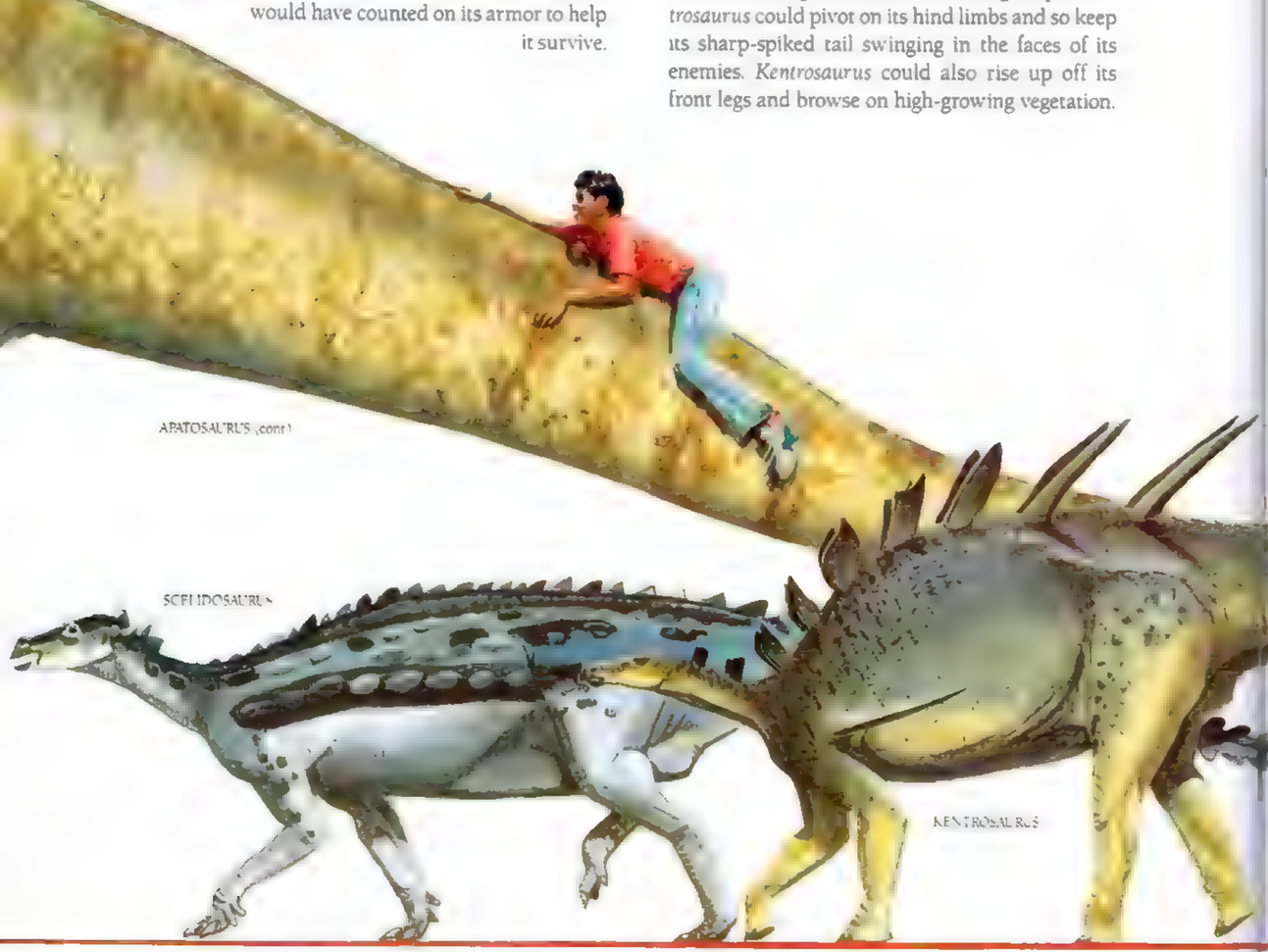
(KEN-truh-sor-uss) "spiked reptile"
Archosauria • Dinosauria • Ornithischia • Stegosauria
Late Jurassic • East Africa • 18 feet long

The fantastic stegosaurs arrived in the Late Jurassic sporting a variety of vertical spikes and plates. These served both as defensive armor and as an aid in giving off excess body heat. Closely related to scelidosaurs, stegosaurs spread world-wide. After the Jurassic, however, nearly all of them disappeared.

The most famous southern stegosaur, scaly *Kentrosaurus*, must have looked like a walking pincushion. Pairs of small, flat plates sprouted from its head to its hips and two-foot-long spikes sprang up along the top of its tail to the tip.

A contemporary of both *Brachiosaurus* and *Dicraeosaurus*, *Kentrosaurus* roamed in herds, finding additional protection in greater numbers. Judging by its toothless beak and small cheek teeth, *Kentrosaurus* ate soft plants that were swallowed whole and left to slowly ferment in its huge belly.

With its weight centered over its high hips, *Kentrosaurus* could pivot on its hind limbs and so keep its sharp-spiked tail swinging in the faces of its enemies. *Kentrosaurus* could also rise up off its front legs and browse on high-growing vegetation.



Stegosaurus

(stegg-uh-SOR-uss) "plated reptile"
Archosauria • Dinosauria • Ornithischia • Stegosauria
Late Jurassic • Colorado, Wyoming • 21 feet long

The largest and most famous of the stegosaurs was *Stegosaurus* itself. Many species are known. Each one has its own variety of plates and spikes. Vertical plates were unique to stegosaurs. Like the scutes of the early archosaurs, plates and spikes were embedded in the skin and were not directly attached to other bones. Evidently plates acted as cooling fins that worked in a similar fashion to the sail on the back of *Dimetrodon* (page 13). In life a horny sheath would have given the plates a razor-sharp edge for extra protection. Near the tip of its tail *Stegosaurus* had from four to eight formidable spikes. In some cases these reached 4 feet in length and would have gored any hungry predator foolish enough to approach them. Young stegosaurs seem to have had neither plates nor spikes.

Among dinosaurs, stegosaurs had the smallest feet. They plodded slowly like an elephant, with very little bend in the knees. Tough pads cushioned each footstep.

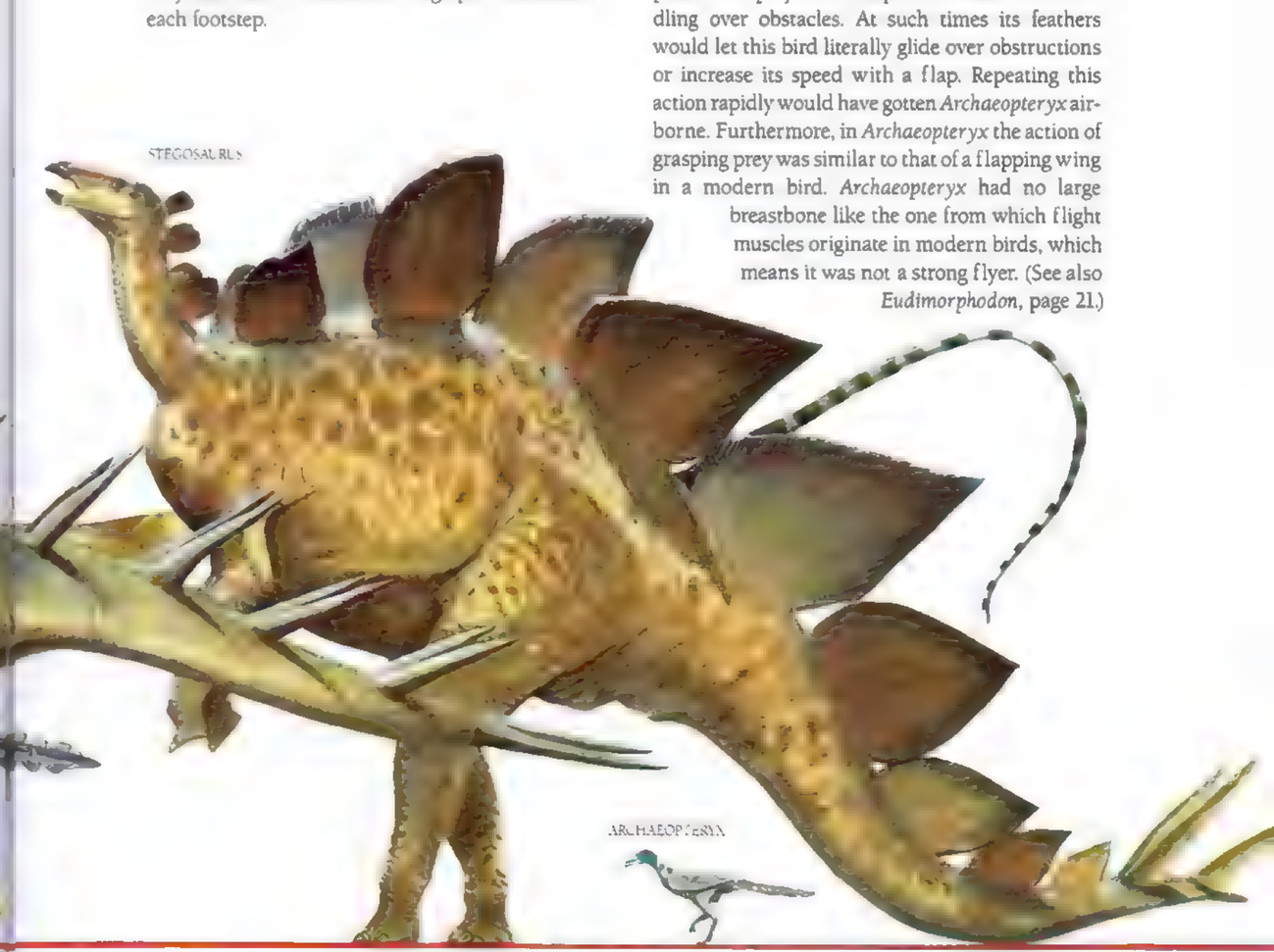
Archaeopteryx

(AR-kee-op-ter-iks) "ancient wing"
Archosauria • Aves • Archaeopterygiformes
Late Jurassic • Germany • 2-foot wingspread

Archaeopteryx is considered to be the first bird because it had feathers, according to well-preserved fossil impressions. Like other birds, *Archaeopteryx* was probably warm-blooded and used its feathers both to insulate itself and to fly. Feathers evolved from enlarged scales.

Without its feathers *Archaeopteryx* had all the features of its relative, the meat-eating dinosaur *Compsognathus* (page 30), except that its hip bones were birdlike and it had longer fingers. *Archaeopteryx* was capable of grasping its prey, unlike modern birds.

Flight seems to have originated not with tree climbing and gliding, as was once thought, but with sprinting on the ground after prey, like a roadrunner. *Archaeopteryx* would have kept its long, dangling fingers and arms folded tightly against its body while running, extending them only to pounce on prey or to keep its balance while hurdling over obstacles. At such times its feathers would let this bird literally glide over obstructions or increase its speed with a flap. Repeating this action rapidly would have gotten *Archaeopteryx* airborne. Furthermore, in *Archaeopteryx* the action of grasping prey was similar to that of a flapping wing in a modern bird. *Archaeopteryx* had no large breastbone like the one from which flight muscles originate in modern birds, which means it was not a strong flyer. (See also *Eudimorphodon*, page 21.)



Leptopterygius

(lep-top-ter-IH-jee-uss) "slender fin
Ichthyosauria • Longipinnatoidea • Leptopterygidae
Early Jurassic • Germany • 30 feet long

Leptopterygius was one of the largest Jurassic ichthyosaurs (fish-shaped, air-breathing marine reptiles). Unlike Triassic ichthyosaurs (page 24) *Leptopterygius* had a large crescent-shaped tail that made it one of the fastest swimmers of its time. Like a shark, *Leptopterygius* had a large, fleshy fin on its back that acted like the keel on a sailboat to counteract the tendency to roll. All known Jurassic ichthyosaurs were built to withstand the pressures of deep dives for fish and squid. Like dolphins, they seem to have traveled together in pods

Eurhinosaurus

(you-rie-noe-SOR-uss) "broad-nosed reptile
Ichthyosauria • Longipinnatoidea • Leptopterygidae
Early Jurassic • Europe • 26 feet long

Eurhinosaurus was a giant slender-finned ichthyosaur shaped like a speedy swordfish. Its upper bill extended far beyond the lower one, yet both bills were lined with teeth all the way to the tips. Perhaps like a swordfish, *Eurhinosaurus* slashed its way through a school of fish or squid, mangling some, dazing others, then circling back for a leisurely lunch

Ophthalmosaurus

(ahf-thal-moh-SOR-uss) "eye reptile
Ichthyosauria • Latipinnatoidea • Ophthalmosauridae
Late Jurassic • Europe, South America • 20 feet long

Ichthyosaurs declined in number and variety after the Early Jurassic. Although common and widespread, *Ophthalmosaurus* is one of the few ichthyosaurs known from later times

Ophthalmosaurus was named for its enormous eyeballs, which were 8 inches in diameter. Most ichthyosaurs had huge eyes for seeing their prey because unlike toothed whales, they had no sonar to guide them. Small teeth lined only the front of *Ophthalmosaurus*'s jaws, suggesting it ate a diet of soft-bodied squid or jellyfish

Ichthyosaurs became totally extinct by the Late Cretaceous, possibly because they failed to compete with other large marine reptiles and sharks, or possibly because of disappearing continental shelves which were their habitat

Plesiosaurus

(plee-zee-uh-SOR-uss) "near lizard
Sauropterygia • Plesiosauria • Plesiosauroidea
Early Jurassic • England • 13 feet long

Plesiosaurs probably swam like penguins and sea turtles, only with two pairs of "wings." Such locomotion is called underwater flying and the swimming stroke resembles a vertical figure 8. The torso of a plesiosaur was rigid between both sets of flippers so that they would transmit all their driving power to the body without it bunching up or stretching out. The top and bottom sets of ribs however, were only loosely connected. If a plesiosaur became stranded on shore, its lungs would have been crushed under the weight of its back

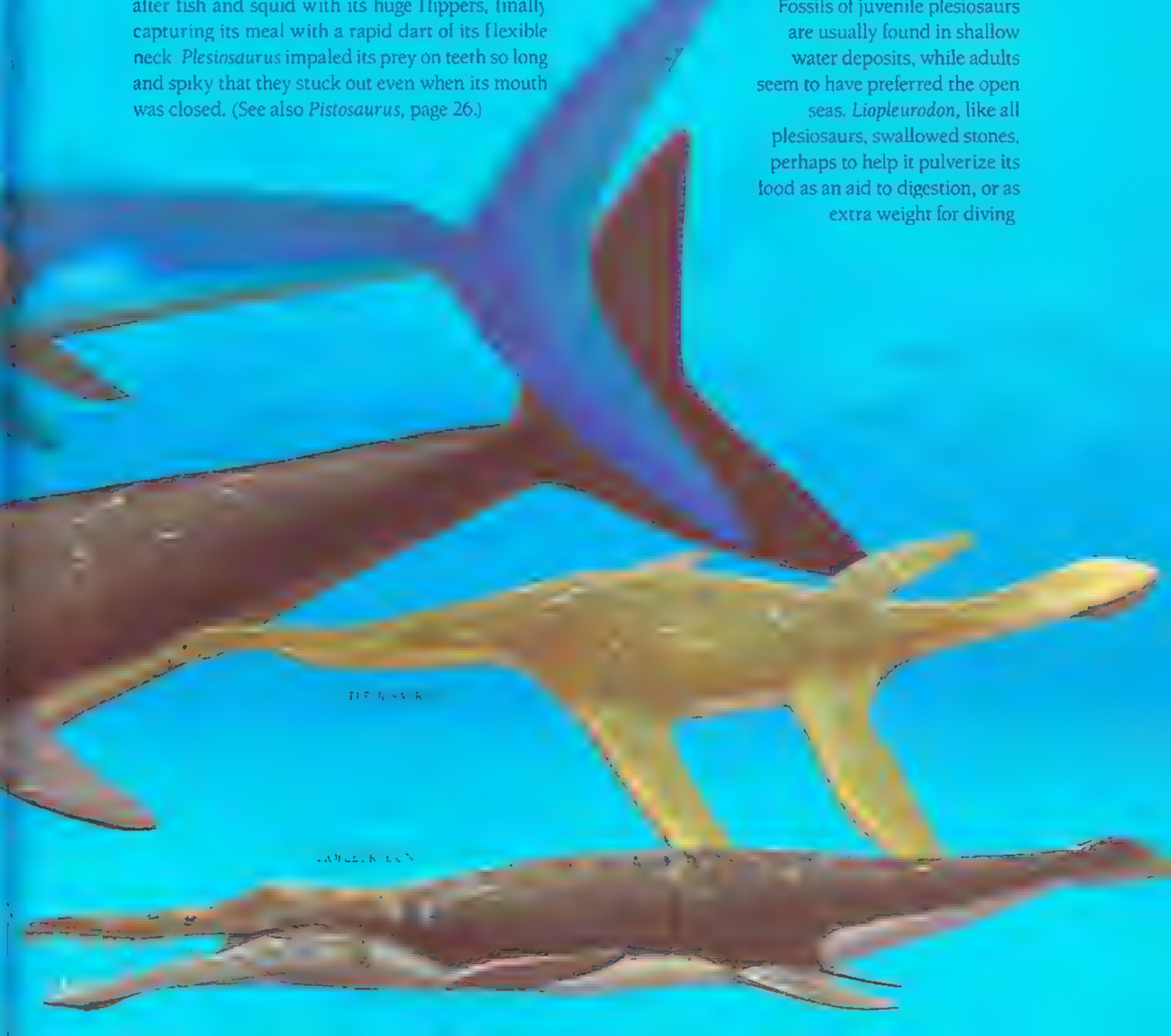
Plesiosaurus was one of the long-necked, small-headed types of plesiosaurs. Like a seal, it chased after fish and squid with its huge flippers, finally capturing its meal with a rapid dart of its flexible neck *Plesiosaurus* impaled its prey on teeth so long and spiky that they stuck out even when its mouth was closed. (See also *Pistosaurus*, page 26.)

Liopleurodon

(lee-uh-PLUR-uh-don) "smooth side tooth
Sauropterygia • Plesiosauria • Pliosauroidea
Late Jurassic • England • 16 feet long

Plesiosaurs with (relatively) short necks and large heads, like *Liopleurodon*, were known as pliosaurs. No doubt this pliosaur ate bigger fish, marine reptiles, and mollusks than *Plesiosaurus* did, so it ate less often. When attacking, *Liopleurodon* employed its entire body in short bursts of great speed, using its large, wide head and flexible neck as a rudder for quick turns underwater. *Plesiosaurus* had a short, rudderlike tail fin. With its equally long tail, *Liopleurodon* may have had one too.

Like other plesiosaurs, *Liopleurodon* had no scales and was probably a lone sea rover Fossils of juvenile plesiosaurs are usually found in shallow water deposits, while adults seem to have preferred the open seas. *Liopleurodon*, like all plesiosaurs, swallowed stones, perhaps to help it pulverize its food as an aid to digestion, or as extra weight for diving



Kronosaurus

(kroe-nuh-SOR-uss) "Kronos [god of time] reptile"
Sauropterygia • Plesiosauria • Pliosauroidea
Early Cretaceous • Australia • 42 feet long

Named for the bloodthirsty mythological god who ate his own children, *Kronosaurus* had the largest head and teeth of any known reptile. Its deadly jaws exceeded 10 feet in length, and its massive bullet-shaped teeth stood nearly 10 inches high. Related to *Liopleurodon* (page 39), this long-bodied plesiosaur must have been the killer whale of its day, eating anything that swam, including other plesiosaurs. *Kronosaurus* could have dived nearly 1,000 feet for a meal of ammonites, those free-swimming squidlike creatures with coiled shells. After a big meal, it probably floated lazily at the surface, raising its nostrils occasionally to spout and take in a fresh supply of air.

KRONOSAURUS

CLIDASTES

Clidastes

(kly-DASS-teez) "key resemblance"
Lepidosauria • Squamata • Lacertilia • Varanoidea
Late Cretaceous • Kansas • 10 feet long

True lizards similar to those living today first appeared as early as the Late Jurassic, 155 million years ago. Throughout their long history, most lizards remained small, sprawling, land-living insect eaters. Monitor lizards are an exception in that they grow larger than other lizards (see *Megalania*, page 61), eat meat, and swim. One side branch of the monitors, the sea-dwelling mosasaurs, became fully aquatic.

Clidastes was one of the earliest mosasaurs. It swam with rapid flicks of its tail, keeping its limbs tucked in except while maneuvering. Shaped like a streamlined torpedo, *Clidastes* had a pointed snout, a large chest, and slick flanks that narrowed to merge with the base of its long, slender tail. A distinct fin emerged near the tip of its tail, which made it faster than some other mosasaurs. Its short, stout limbs were webbed but had not become flippers. They were rather small, making *Clidastes* less able to maneuver than other mosasaurs. It probably preyed on fish and squidlike mollusks that weren't able to corner very quickly.

HAINOSAURUS

Thalassomedon

thuh-LASS-so-meh-don "[sea] the sea tooth"
Sauropterygia • Plesiosauria • Plesiosauroidea
Late Cretaceous • Colorado • 39 feet long

Thalassomedon was one of the largest of the elasmosaurs, later relatives of *Plesiosaurus* (page 39) with much longer necks. *Thalassomedon* had a 19-foot neck, half the total length of its body. Although the neck contained 62 vertebrae, it was stout and stiff near the body, for stability, and increasingly flexible near the head, especially in the downward direction. *Thalassomedon* may have been a slow, steady swimmer that "grazed" throughout the day, dipping its head into schools of fish and squid for a meal. Each time its head and neck veered off to the side, they would have acted like a rudder to turn the entire animal. Both pairs of fins had to move constantly to keep *Thalassomedon* on a steady course. The stubby tail would have been useless as a rudder. *Thalassomedon* had 28 long, sharp fish-trap teeth in its lower jaws and only 8 in its uppers. All of its teeth stayed exposed like thorns when the jaws were closed.

Hainosaurus

(hane-uh-SOR-uss) "Hainaut [Belgium] lizard"
Lepidosauria • Squamata • Lacertilia • Varanoidea
Late Cretaceous • Belgium • 52 feet long

The largest lizard of all time was *Hainosaurus*. Rivaling the sea serpents of myth, this eel-like sea lizard must have been a rapacious killer with sharp, deadly teeth lining its jaws. As in all living lizards and snakes, *Hainosaurus*'s old worn teeth were shed every so often, making room for sharp new teeth that were constantly growing in. An extra set of teeth grew from the roof of its throat to ensure that prey could not escape once it was headed toward the stomach.

Dolichorhynchops

(dole-ih-koe-RIN-kops) "long nose face"
Sauropterygia • Plesiosauria • Pliosauroidea
Late Cretaceous • Kansas • 11 feet long

Dolichorhynchops was a smaller version of *Kronosaurus* with a longer pointed snout, a longer neck, and a more pronounced "forehead" housing large jaw muscles. Like a seal, it was highly flexible in the water, and may have been able to single out one particular fish darting from its school and chase it till captured.

DOLICHORHYNCHOPS

THALASSOMEDON

Plotosaurus

(ploh-toe-SOR-uss) "swimming lizard"
Lepidosauria • Squamata • Lacertilia • Varanoidea
Late Cretaceous • California • 32 feet long

Plotosaurus may have been one of the fastest mosasaurs. It had a very deep chest, probably to enclose a large set of lungs, and a large tail fin for speed. Its limbs were solid flippers like those of a plesiosaur but were used only for steering, not for paddling.

All lizards, including mosasaurs, have flexible jaw hinges that bow out to allow extra-large prey to be swallowed. Movable jaw and skull joints also enabled mosasaurs to shift a large slippery fish around in the mouth without losing a grip on it underwater. A fish couldn't be swallowed easily until it was pointed headfirst down the throat.

Stomatosuchus

(stoe-mah-toe-SOOK-uss) "mouth crocodile"
Archosauria • Crocodilia • Eusuchia • Stomatosuchidae
Late Cretaceous • Libya • 36 feet long (est.)

Stomatosuchus was a bizarre giant crocodilian without any teeth at all in its long, slender lower jaw. Only tiny, widely spaced teeth rimmed its upper jaw beneath a broad, flat 6-foot-long skull. The lower jaw had a special flange that most likely supported a huge pelicanlike chin sack. These features suggest that this unusual crocodilian was a filter feeder that may have fed like the blue whale. Gorging its chin sack full of water containing fish or plankton, *Stomatosuchus* may have risen upside down to the surface, letting gravity drain the sack while its tiny teeth strained out whatever food it had managed to capture.

Stomatosuchus lived in lush coastal swamps covering what has now become the Sahara Desert. Only one fossil skull of this strange crocodilian has so far been discovered. Unfortunately it was housed in Germany during World War II and destroyed by a bomb.

Deinosuchus

(die-nuh-SOOK-uss) "terror crocodile"
Archosauria • Crocodilia • Eusuchia • Crocodylidae
Late Cretaceous • Texas • 52 feet long (est.)

One of the largest crocodiles that ever lived was *Deinosuchus* (also known as *Phobosuchus*). This cold-blooded king of the tropical rivers and marshes had fewer but longer teeth than the modern crocodiles it otherwise resembled. It must have used these long teeth to bite unwary dinosaurs and then drag them underwater to their doom.

The skull, a few loose bones, and a few large scutes are all that is known of this prehistoric giant. Because they resemble those of many living crocodiles, we can make a good guess at *Deinosuchus*'s likely appearance and habits.

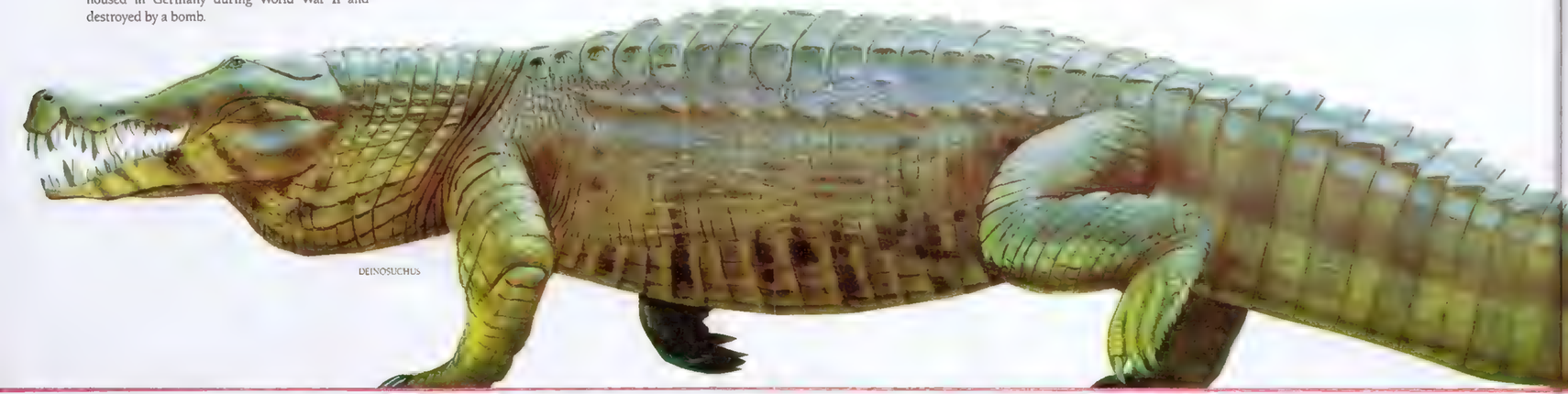
Deinosuchus's low, flat 6-foot-long skull was topped by protruding nostrils and eyes. With only these breaking the surface, *Deinosuchus* could float at the water's edge unnoticed by its prey on land. It also ate fish, marine reptiles, and anything that fell into the water. *Deinosuchus* could reduce large prey to bite-size pieces by clamping it securely in its jaws and viciously twisting and whipping it about until the victim fell apart. Digestion was aided with stomach stones that pulverized unchewed food.

Deinosuchus swam by making broad sinuous sweeps of its tall, narrow tail. On land it lazed about in the sun, but might have run faster than a person in a short sprint. While thrashing about, it could have knocked any large foe to the ground.

Deinosuchus probably laid its eggs in carefully hidden nests and kept watch over its hatchlings' safety in the wild. A mother crocodile is notoriously protective of her young, offering them rides on her back or gently within her open mouth

Like living crocodilians, but unlike the earliest types (page 21), *Deinosuchus* had a complete secondary palate, a shelf of bone separating the nasal passages from the mouth cavity. This feature allowed *Deinosuchus* to eat and breathe at the same time. Its skull was very heavily constructed, which helped it withstand the violent thrashing of victims

With few exceptions crocodilians are and were covered with bony scutes. Scutes not only provide body armor but also help support the long backbone through their tough, sinewy connections to the bones and muscles of that area. The heavy tail pulls the long backbone into a graceful arch, which lifts the belly clear off the ground while the crocodile roves about on land. (See also *Rhamphosuchus*, page 60.)



Dakosaurus

dak-uh-SOR-uss) "bite reptile"
Archosauria • Crocodilia • Mesosuchia • Metriorhynchidae
Late Jurassic to Early Cretaceous • Europe • 20 feet long

Dakosaurus was one of the largest, and the last, of the thalattosuchians or "sea crocodiles." They were the only archosaurs to take up a completely marine existence. Originating during the Middle Jurassic in Europe and South America (at that time parts of one supercontinent), sea crocodiles existed only into the Early Cretaceous, dying out along with the ichthyosaurs (page 38).

Dakosaurus had smooth, scaleless skin, which streamlined its body, and an ichthyosaur-like tail fin for swimming in the sea. Its front limbs were very small steering fins with all five digits wrapped together as a flipper. Its hind limbs were not flippers but legs that must have been kept tucked in at the sides. Perhaps *Dakosaurus* females still needed legs to come ashore in order to build a nest and lay eggs. They likely returned to the shallows of freshwater rivers to breed so that their young could grow in comparative safety before returning to the sea Males may have never returned to land

Dakosaurus probably ate fish. Its head was small in comparison to most crocodiles, and short in comparison to other sea crocs. The skull was smooth and streamlined, not pitted as in most crocodilians. *Dakosaurus* had fewer neck bones than usual for a crocodilian, making its neck less flexible. Its eyes were on either side of its head, not on top as in other crocodiles. Extra-broad bony eye shades gave *Dakosaurus* a permanent "eagle-eye" frown and protected its eyes from damage.

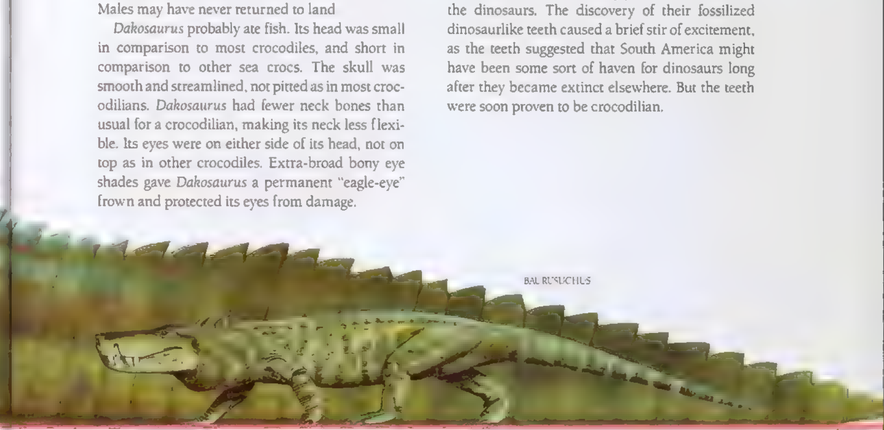
Baurusuchus

(bough-ruh-SOOK-uss) "Bauru [formation] crocodile"
Archosauria • Crocodilia • Mesosuchia • Baurusuchidae
Late Cretaceous • Brazil • 7 feet long (est.)

Baurusuchus was one of the South American land crocodiles, a group with a long history largely separate from that of the typical aquatic crocodiles. With its short, high snout and serrated, knifelike teeth *Baurusuchus* looked, and probably behaved, much like *Ornithosuchus* (page 20) or the living Komodo dragon. It probably waited in the bush for prey to happen by, then attacked with a quick bite, snagging its victim on its huge teeth and shaking it to death

Only the skull of *Baurusuchus* is known. From other closely related species we know that it probably was armored with scutes like a typical crocodile. As a land rover, *Baurusuchus* likely had longer legs, a shorter body, and a round, lizardlike tail, not the tall, narrow tail of a swimming crocodile.

Land crocs survived long past the extinction of the dinosaurs. The discovery of their fossilized dinosaurlike teeth caused a brief stir of excitement, as the teeth suggested that South America might have been some sort of haven for dinosaurs long after they became extinct elsewhere. But the teeth were soon proven to be crocodilian.



Pterodactylus

(ter-uh-DAK-tuh-luss) "wing finger"
Archosauria • Pterosauria • Pterodactyloidea
Late Jurassic • Germany • 2-foot wingspread

The first wave of pterosaurs, the rhamphorhynchoids (see *Eudimorphodon*, page 21, and *Dimorphodon*, page 35), had long tails, relatively short necks, short hands, short heads, and a long fifth toe. Just prior to the dawn of the Cretaceous, the second wave of pterosaurs, the pterodactyloids, arrived in the form of tiny *Pterodactylus*, the smallest of them all. It had a long face, neck, and hands, a tiny tail, and a tiny fifth toe. Evidently *Pterodactylus*'s wing membrane extended to halfway down its thigh, which allowed the leg muscles to control the wing's lift and braking, acting like the flaps on the trailing edge of an airplane wing. Only pterodactyloids survived into the Cretaceous.

Except for lacking feathers, *Pterodactylus* was very much like a big sandpiper. It probably flitted from beach to beach, riding the gentle breezes coming in off the oceans. Its long, toothy bill would have made an effective probe for sandworms and small crustaceans.

Dsungaripterus

(joon-gar-IP-ter-uss) "wing from Jungar [China]"
Archosauria • Pterosauria • Pterodactyloidea
Early Cretaceous • China • 10-foot wingspread

Dsungaripterus was a pterosaur with a low crest atop its beak and another at the back of its head. The tip of its beak was shaped like a sharp upturned forceps and would have been useful in removing mollusks such as clams and ammonites from their shells. Toward the back of its jaws, *Dsungaripterus*'s teeth were broad and flat, ideal for crushing the shells of smaller mollusks to extract their meat.

Pteranodon

(ter-AN-uh-don) "wings without teeth"
Archosauria • Pterosauria • Pterodactyloidea
Late Cretaceous • Kansas • up to 24-foot wingspread

Like a giant albatross, *Pteranodon* soared above the inland seas that once covered the grain belt of mid-America. Skimming the surface, *Pteranodon* plucked out squidlike mollusks, fish, and other small animals for lunch. The catch was saved in a shallow, pelicanlike throat sack beneath its long beak. Like many later pterosaurs, *Pteranodon* had no teeth.

Seabirds are the least colorful of birds, and perhaps coast-dwelling pterosaurs were similarly drab. *Pteranodon*'s distinctive crest would then have been useful in attracting mates of its own species. *Pteranodon ingens* had a long crest extending 2 feet beyond the back of its skull. This featherweight decoration was only 1/8-inch thick in places. Larger still was *Pteranodon sternbergia*, known from an incomplete skull and notable for its very tall, ornate head crest.

Quetzalcoatlus

(ket-sahl-koe-AHT-luss) "[Aztec] feathered serpent god"
Archosauria • Pterosauria • Pterodactyloidea
Late Cretaceous • Texas • 35-to-40-foot wingspread

The largest flying animal of all time was *Quetzalcoatlus*. With a wingspread rivaling that of a small private plane and a weight estimated at only 150 pounds, this storklike pterosaur must have been able to soar effortlessly for hours, ranging dozens of miles each day. Unlike fossils of other pterosaurs, those of *Quetzalcoatlus* were found far from the ancient seacoast. Like a great egret, this flyer may have fished in inland streams and lakes. It had a toothless bill measuring 7 feet in length, which may have been used to spear fish. Its long neck had little flexibility from side to side, which helped *Quetzalcoatlus*'s head resist crosswinds that would have twisted it like a weather vane. Among pterosaurs, only *Quetzalcoatlus* is known to have survived until the very end of the Cretaceous Period.

Of the very few birds that are known to have been the contemporaries of pterosaurs during the Cretaceous, all are shore birds and some had teeth. Birds are only distant cousins of pterosaurs, however; they are much more closely related to dinosaurs. (See *Archaeopteryx*, page 37.)

Pterodaustro

(ter-uh-DAWS-troe) "wing of the south"
Archosauria • Pterosauria • Pterodactyloidea
Early Cretaceous • Argentina • 10-foot wingspread

The teeth of *Pterodaustro* were quite numerous and shaped like long, flexible needles. Looking much like today's avocet, this pterosaur evidently waded into shallows, dipped its long, narrow, upturned beak into plankton-rich waters, and combed out bits of small plant and animal life with its strainer teeth.

Iguanodon

(ih-GWAN-uh-don) "iguana tooth"
Archosauria • Dinosauria • Ornithischia • Ornithopoda
Early Cretaceous • Europe, Asia, North Africa • 30 feet long

In the 1820s an English country doctor named Gideon Mantell compared fossil teeth he had found to those of the living iguana and concluded that his fossils had come from a 40-foot-long prehistoric lizard. He named it *Iguanodon*. This was, instead, one of the first dinosaurs to be discovered, though the term "dinosaur" was not to be coined for another 20 years.

Iguanodon was one of the ornithopods, unarmored, beaked plant eaters that were later relatives of *Fabrosaurus* (page 23). *Iguanodon* was larger and so walked on all fours, at least part of the time. *Iguanodon* had an upper horny beak to match its lower one, which made cropping low-growing plants easier. Behind its beak was a single row of plant-chopping teeth. Cheeks kept the chopped-up bits from falling out.

Iguanodon's middle three fingers were bound together in a "mitten" that gave its handprint a crescent shape. Its fifth finger remained free, perhaps to grasp branches against the palm. Its first digit was a large horn-shaped spike of bone that stuck out at a right angle to the hand. *Iguanodon* was not particularly fast and, lacking horns and armor, may have defended itself by jabbing its "thumb" spike into its attackers.

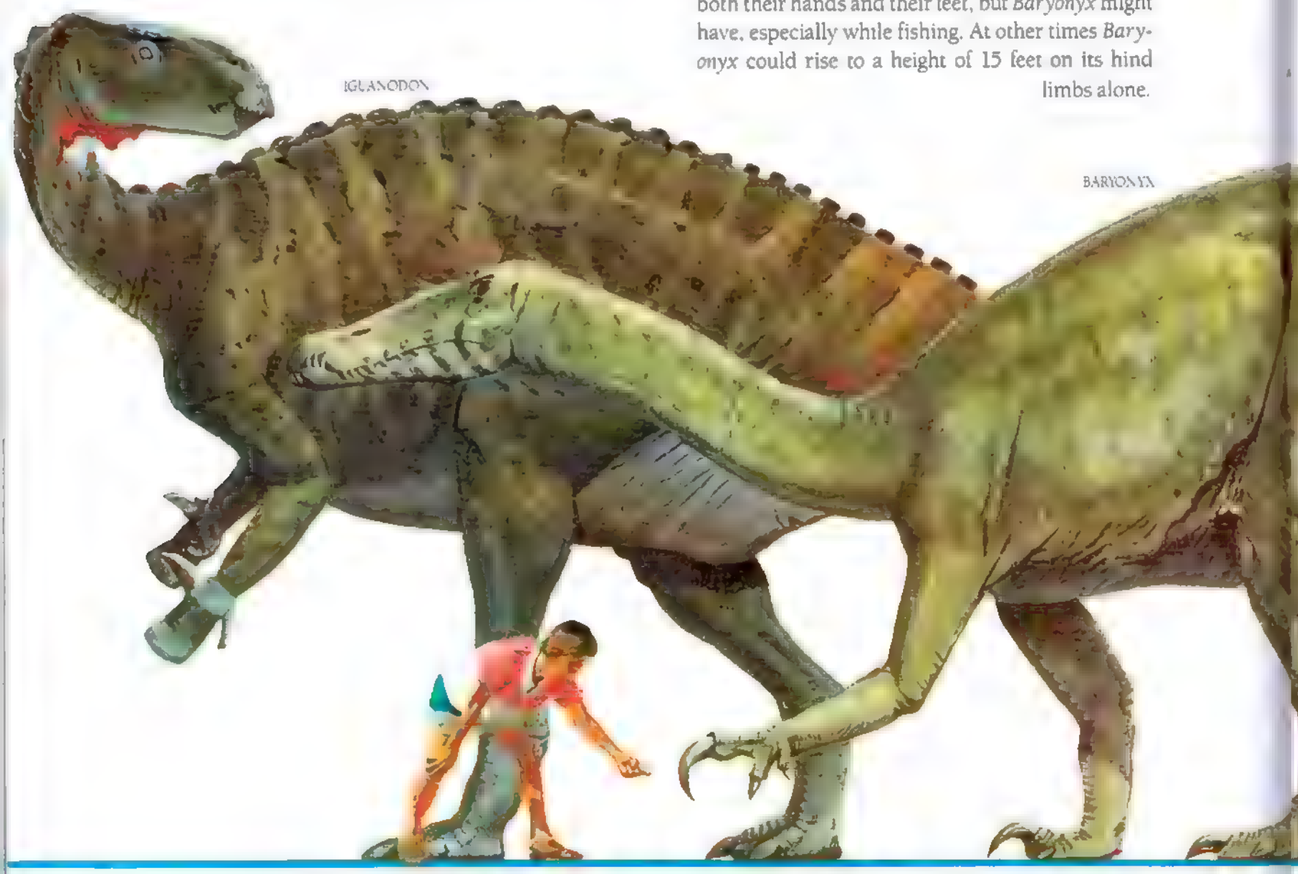
Baryonyx

(bar-ee-ON-iks) "heavy claw"
Archosauria • Dinosauria • Saurischia • Theropoda
Early Cretaceous • England • 30 feet long

Recently discovered *Baryonyx* was unlike any other meat-eating theropod. Instead of chasing prey on land, this 4,000-pound dinosaur may have been a fish eater that waded out in shallow water, like a grizzly bear, to gaff passing fish with its huge 12-inch claws.

Baryonyx had a long, low head like that of a crocodile, but its nostrils were far from the tip of its snout. This predator could continue breathing while its spoon-shaped mouth probed the waters. Compared to other theropods, *Baryonyx* had nearly twice the usual number of teeth in its jaws. To top it all off, a small horn rose above the middle of its muzzle.

Meat-eating dinosaurs usually did not walk on both their hands and their feet, but *Baryonyx* might have, especially while fishing. At other times *Baryonyx* could rise to a height of 15 feet on its hind limbs alone.



Segnosaurus

(seg-noe-SOR-uss) "slow lizard"
Archosauria • Dinosauria • Segnosauria
Late Cretaceous • Mongolia • 20 feet long (est.)

Not enough is known yet to classify *Segnosaurus* as either a saurischian or an ornithischian dinosaur. It had a strange mix of body parts from both groups. It was not an evolutionary link between the two groups because it lived 130 million years after they separated.

Like the saurischian *Plateosaurus* (page 23), *Segnosaurus* had a small head on the end of a slender neck and four toes armed with long claws on each hind foot. It could walk on all fours or rise to its hind legs alone, displaying an even larger set of daggerlike claws on its hands. Powerful defensive weapons, these claws may also have been used to tear down branches. One supposed segnosaur, known only from a single forelimb, had front claws 27 inches long, the longest among dinosaurs.

Like that of the ornithischian *Iguanodon*, *Segnosaurus*'s snout was tipped with a horny, toothless beak. Its hipbones were shaped like saurischian hips but were positioned like those of ornithischians. The hips and ribs flared widely to either side, giving *Segnosaurus* an unusually large gut for digesting a big batch of plant food.

In the Late Cretaceous the plains of Mongolia were seasonally dry, with numerous streams crossing the countryside. Many kinds of dinosaurs roamed these plains, but *Segnosaurus* would have feared only large tyrannosaurs and small flocks of birdlike dinosaurs similar to *Deinonychus*.

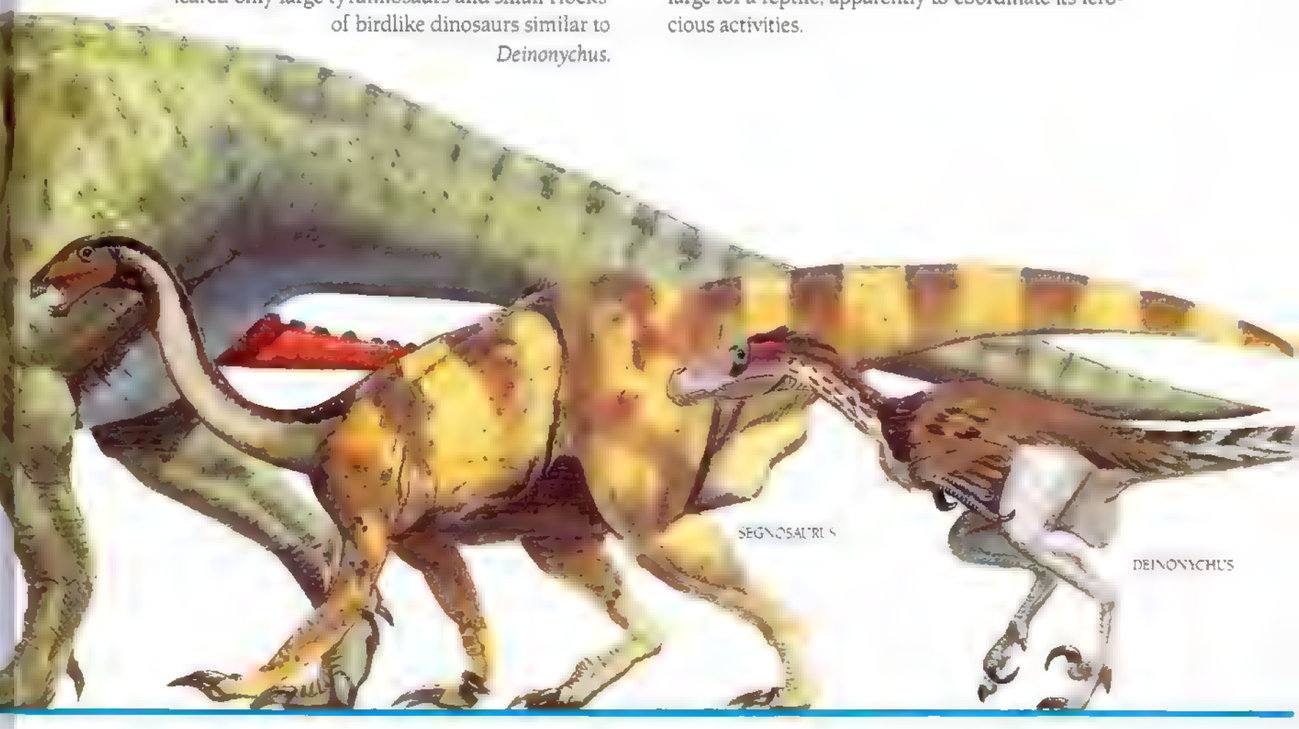
Deinonychus

(die-NON-ee-kuss) "terrible claw"
Archosauria • Dinosauria • Saurischia • Theropoda
Early Cretaceous • Montana • 13 feet long

Unlike all other theropods, *Deinonychus* had hips set in a birdlike position with the pubic bone pointing backward rather than forward. Birds, such as *Archaeopteryx*, had similar hips. This feature, and others, points to *Deinonychus*'s kinship with birds. This 100- to 150-pound creature was possibly warm-blooded and may, in fact, have been one of the first flightless birds.

Deinonychus would have made a superb killing machine using its teeth, clawed fingers, and toes as weapons. The second toe of each foot bore an extra-large curved claw that was carried in a retracted position so that it was never dulled by contact with the ground. Running in vicious flocks or packs, *Deinonychus* could ambush dinosaurs the size of *Iguanodon*. Leaping on its prey, it locked on with long fingers and claws like grappling hooks and slashed its victim to death with its extra-large toe claws.

Deinonychus had special interlocking vertebrae that stiffened its tail, letting the tail move as a unit and act as a balancing pole. This was very important to a predator that stood and balanced on one foot while kicking and slashing with the other. Unlike those of most dinosaurs, *Deinonychus*'s eyes pointed partly forward, which helped it judge distances while leaping. Its brain was particularly large for a reptile, apparently to coordinate its ferocious activities.



Saltasaurus

(salt-uh-SOR-uss) "Salta [province of Argentina] reptile"
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Late Cretaceous • Argentina • 40 feet long

Saltasaurus is the first sauropod (long-necked saurischian plant eater) known to have been armored with bony scutes, like those of *Sauropelta* (next page). This armor came in two sizes: pebble-size nodules and saucer-size plates. Armor plating protected peaceful *Saltasaurus* from attacks by fierce meat eaters such as *Carnotaurus*. In addition the long, thin portion at the end of its tail could whip large aggressors and knock down smaller ones.

Distantly related to *Dicraeosaurus* (page 34), *Saltasaurus* was one of the titanosaurs, widespread sauropods with steeply sloping faces, tiny pencil-like teeth only in the front of their jaws, and relatively short neck bones. Titanosaurs laid eggs that were about the size of a football. Hatchlings must have grown quickly!

Saltasaurus, like all sauropods, had a body resembling that of an elephant: big in the belly and slender in the legs. Its rear feet bore three large claws that could be kicked at aggressors. Its buttonlike "fingers" were wrapped together in a single "mitten" that rested on a crescent-shaped pad.

Pachycephalosaurus

(pak-ee-sef-uh-loe-SOR-uss) "thick-headed reptile"
Archosauria • Dinosauria • Ornithischia • Pachycephalosauria
Late Cretaceous • Western United States • 17 feet (est.)

Pachycephalosaurus was an unusual unarmored, beaked plant eater. It had a distinctive domed skull, filled not with brains but with up to 9 inches of solid bone. Evidently *Pachycephalosaurus* used its "dome head" as a ramming weapon against both rivals and enemies. In most reptiles the neck attaches at the back of the head, but *Pachycephalosaurus*'s neck attached to the bottom of its skull, as in humans. When *Pachycephalosaurus* lowered its head for a charge, its neck was lined up with its backbone to absorb the shock of impact. Above its beaked snout and along the back of its skull a number of small conical horns, too short to have punctured anything, acted as intimidating decorations.

Only the skull is known from this, the largest of all pachycephalosaurs. Related smaller species indicate that its body was probably similar to those of other two-legged plant eaters only much wider, especially just fore and aft of the hips. The ribs flared widely to enclose a huge gut. Pachycephalosaurs had wide-flaring tail ribs, too, like no other animals ever. Possibly these provided an additional chamber for a portion of the intestines aft of the hips.

The end of *Pachycephalosaurus*'s tail was quite narrow and stiffened with a mass of bony tendons similar to those that corseted the back and hips of most ornithischians. These made the tail into a balancing rod that may have improved this dinosaur's stability while running, especially when cornering.

Carnotaurus

(kar-noe-TOR-uss) "meat-eating bull"
Archosauria • Dinosauria • Saurischia • Theropoda
Late Cretaceous • Argentina • 30 feet long

Carnotaurus of South America was a ferocious midsize meat eater with a short snout, a high skull, and two large horns over its eyes. No other meat eater had horns as large as these. They weren't large enough or sharp enough to have killed prey, so they may have been purely decorative.

Carnotaurus had a large crest at the back of its skull, forming a sturdy support for heavy neck muscles. Large muscles also drove its large hind legs across the floodplains as *Carnotaurus* sought sauropods and hadrosaurs to kill and eat. Despite its narrow mouth, flexible joints in the middle of its lower jaw enabled *Carnotaurus* to swallow large chunks of meat whole.

Sauropelta

(sor-uh-PEL-tah) "reptile with shield"
Archosauria • Dinosauria • Ornithischia • Ankylosauria
Early Cretaceous • Montana • 17 feet long

Peaceful ankylosaurs were the most heavily armored of the four-legged, beaked plant eaters. One of the largest, *Sauropelta*, had its entire upper body covered in bony scutes. Even the head and eyelids had an extra layer of protective bone. Like those of other ankylosaurs, *Sauropelta*'s hipbones folded over to become protective plates covering its wide rump.

In contrast to its cousin *Euoplocephalus* (page 55), *Sauropelta* had a narrow pear-shaped skull and large, sharp spikes lining its neck. This heavily muscled tanklike dreadnought may have charged at adversaries, intent on damaging them with its spikes. Most of the time, however, it browsed quietly on soft plants in the deep forests.

Protoceratops

(pro-toe-SER-uh-tops) "first horned face"
Archosauria • Dinosauria • Ornithischia • Ceratopsia
Late Cretaceous • Mongolia • 6 feet long

Parts of Mongolia have been particularly rich sources of fossils because periodic floods and sandstorms buried many species.

Protoceratops was one of the earliest ceratopsians. These bird-hipped plant eaters had a parrotlike beak and a large shield formed by an extension of the upper skull bones. Primarily the powerful jaw muscles originated from this shield, but it also served to protect the neck, intimidate rivals and enemies, and attract mates. With the strongest jaws of all dinosaurs, ceratopsians could have eaten almost any kind of plant. The cheek teeth acted like scissors to slice food into tiny strips while fleshy cheeks kept the pieces from falling out.

The first dinosaur eggs ever discovered were those of *Protoceratops* in the 1920s. They were leathery and oblong, laid in a circle within a shallow sandy pit in the Mongolian desert. Colonies of this dinosaur nested together, guarding their eggs from nest robbers like *Oviraptor* (page 54).

Shantungosaurus

(shan-tung-uh-SOR-uss)
"Shantung [province of China] reptile"
Archosauria • Dinosauria • Ornithischia • Ornithopoda
Late Cretaceous • China • 56 feet long

Shantungosaurus was one of the largest of all the hadrosaurs, or duck-billed dinosaurs. A hadrosaur's snout only looked like a duck's bill. Ducks have no teeth, but hadrosaurs had thousands. *Shantungosaurus* was a better plant grinder than its relative *Iguanodon* (page 48). Not one, but a number of rows of teeth were exposed to act like millstones, crushing and pulverizing conifer cones, needles, and twigs. With its wide "duck bill," *Shantungosaurus* was able to crop large mouthfuls at a time. It might not have needed a large gut because its food was so thoroughly processed before entering its stomach.

Apart from its size—up to 40,000 pounds—*Shantungosaurus* was defenseless. Perhaps it fled to the swamps whenever danger lurked. *Shantungosaurus* could run on its hind legs alone, using its tall, narrow tail as a counterbalance.

Euhelopus

(you-HEHL-uh-puss) "true marsh foot"
Archosauria • Dinosauria • Saurischia • Sauropodomorpha
Early Cretaceous • China • 45 feet long

Euhelopus was a 30,000-pound plant-eating sauropod with an extremely long neck and a short tail. Like its distant relative *Brachiosaurus* (page 31), it had stout teeth rimming its entire jawline. *Euhelopus* had 17 neck bones, two to five more than most sauropods. The vertebrae over the hips were quite low, making it more difficult for this sauropod to have stood on its hind legs alone. With such a long neck, it didn't need to. No doubt it browsed like a giraffe among the treetops, migrating in herds, following the seasonal rainfall.

Alioramus

(ah-lee-oh-RAH-muss) "other branch"
Archosauria • Dinosauria • Saurischia • Theropoda
Late Cretaceous • Mongolia • 17 feet long (est.)

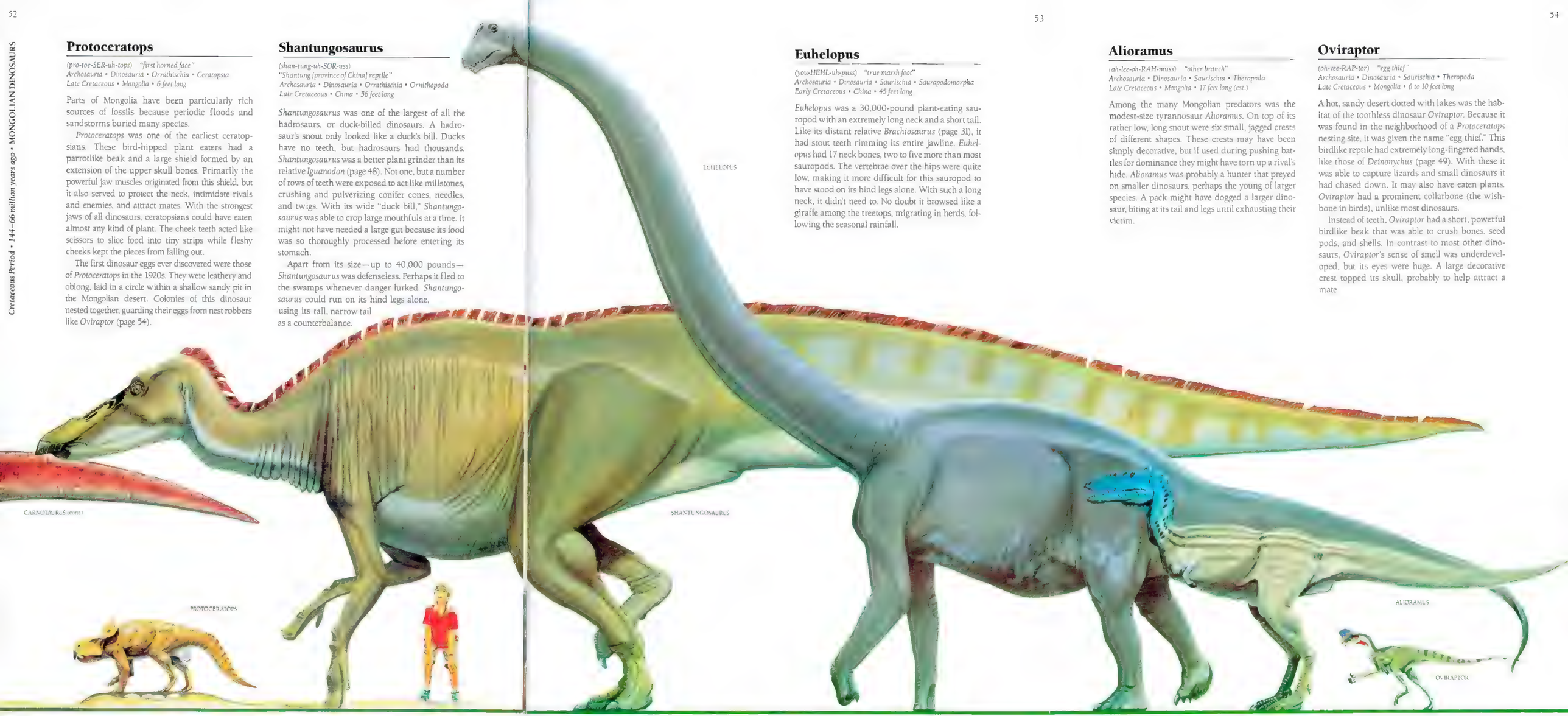
Among the many Mongolian predators was the modest-size tyrannosaur *Alioramus*. On top of its rather low, long snout were six small, jagged crests of different shapes. These crests may have been simply decorative, but if used during pushing battles for dominance they might have torn up a rival's hide. *Alioramus* was probably a hunter that preyed on smaller dinosaurs, perhaps the young of larger species. A pack might have dogged a larger dinosaur, biting at its tail and legs until exhausting their victim.

Oviraptor

(oh-vee-RAP-tor) "egg thief"
Archosauria • Dinosauria • Saurischia • Theropoda
Late Cretaceous • Mongolia • 6 to 10 feet long

A hot, sandy desert dotted with lakes was the habitat of the toothless dinosaur *Oviraptor*. Because it was found in the neighborhood of a *Protoceratops* nesting site, it was given the name "egg thief." This birdlike reptile had extremely long-fingered hands, like those of *Deinonychus* (page 49). With these it was able to capture lizards and small dinosaurs it had chased down. It may also have eaten plants. *Oviraptor* had a prominent collarbone (the wishbone in birds), unlike most dinosaurs.

Instead of teeth, *Oviraptor* had a short, powerful birdlike beak that was able to crush bones, seed pods, and shells. In contrast to most other dinosaurs, *Oviraptor*'s sense of smell was underdeveloped, but its eyes were huge. A large decorative crest topped its skull, probably to help attract a mate



Euoplocephalus

(you-o-pluh-SEF-uh-luss) "well-armored head"
Archosauria • Dinosauria • Ornithischia • Ankylosauria
Late Cretaceous • Alberta • 20 feet long

The dinosaurs on these three pages all died in lush tropical rain forests dotted with marshes, ponds, and brooks, ideal places for fossilization to take place.

"Well-armored" *Euoplocephalus* was one of the largest of the ankylosaurs. In contrast to *Sauropelta* (page 51), *Euoplocephalus* had no flank spikes and its tail had a bony club, shaped like twin spheres, at its tip. It probably swung this club at attacking tyrannosaurs to trip them up. *Euoplocephalus*'s head was broader than it was long, and large pyramidal horns made corners out of the back of the skull. *Euoplocephalus* might easily have smelled an approaching enemy because its nasal passages were long and complex, increasing its sensitivity to odors. Perhaps these passages also formed a resonating chamber for producing strange nasal sounds.

Euoplocephalus was a slow-moving dinosaur that spent lazy days grazing on soft ground plants, cropped with its broad beak. But when attacked, *Euoplocephalus* could have moved with surprising agility, keeping its massive tail club aimed and ready to strike.

Lambeosaurus

(lam-bee-uh-SOR-uss) "[Lawrence] Lambe's reptile"
Archosauria • Dinosauria • Ornithischia • Ornithopoda
Late Cretaceous • Alberta, Baja California
up to 54 feet long (est.)

Lambeosaurus was a 50,000-pound, long-legged, hollow-crested hadrosaur. Its crest was an expansion of its nasal cavity, which might have amplified a squeal or a whistle to ear-shattering volume. Larger crests identified dominant members of a herd. Although *Lambeosaurus* fossils have been found in formerly marshy areas, its diet consisted of hard woody items such as conifer cones, needles, and stems, more likely to be found in upland regions. This hadrosaur's jaws ground food to bits by moving forward and back, as rodents' jaws do.

Like birds, lambeosaur hatchlings grew quickly, staying in the nest colony for the first few weeks while waiting for their parents to bring them partly digested foods.

Dromiceiomimus

(droe-me-see-o-ME-muss) "emu mimic"
Archosauria • Dinosauria • Saurischia • Theropoda
Late Cretaceous • Alberta • 11 feet long

Like an ostrich without feathers, slender *Dromiceiomimus* may have raced at speeds approaching 40 miles per hour, dodging through forest clearings on its long sprinter's legs. Perhaps it was the fastest of all dinosaurs. Like other ornithomimids ("bird mimics"), *Dromiceiomimus* had a tiny head, huge eyes, and a long, flexible skinny neck. On each long hand were three long-clawed fingers, two of which may have been wrapped together as a unit. They were not built for grasping or raking. *Dromiceiomimus*'s diet is unknown, but perhaps this dinosaur was a plant eater, hooking low fruit-laden branches with its claws and pulling them up to its toothless beak.

Parasaurolophus

(pair-uh-sor-OL-uh-fuss) "similar to the reptile with a crest"
Archosauria • Dinosauria • Ornithischia • Ornithopoda
Late Cretaceous • Alberta, New Mexico, Utah • 33 feet long

This hadrosaur's hollow nasal crest was composed of twin tubelike nasal passages. They extended as far as 3½ feet behind *Parasaurolophus*'s head before doubling back along the underside to re-enter the skull between the eyes and above the throat. This resonating chamber would have produced an unusual low trumpeting sound.

Styracosaurus

(sty-rak-uh-SOR-uss) "spiked reptile"
Archosauria • Dinosauria • Ornithischia • Ceratopsia
Late Cretaceous • Alberta • 18 feet long

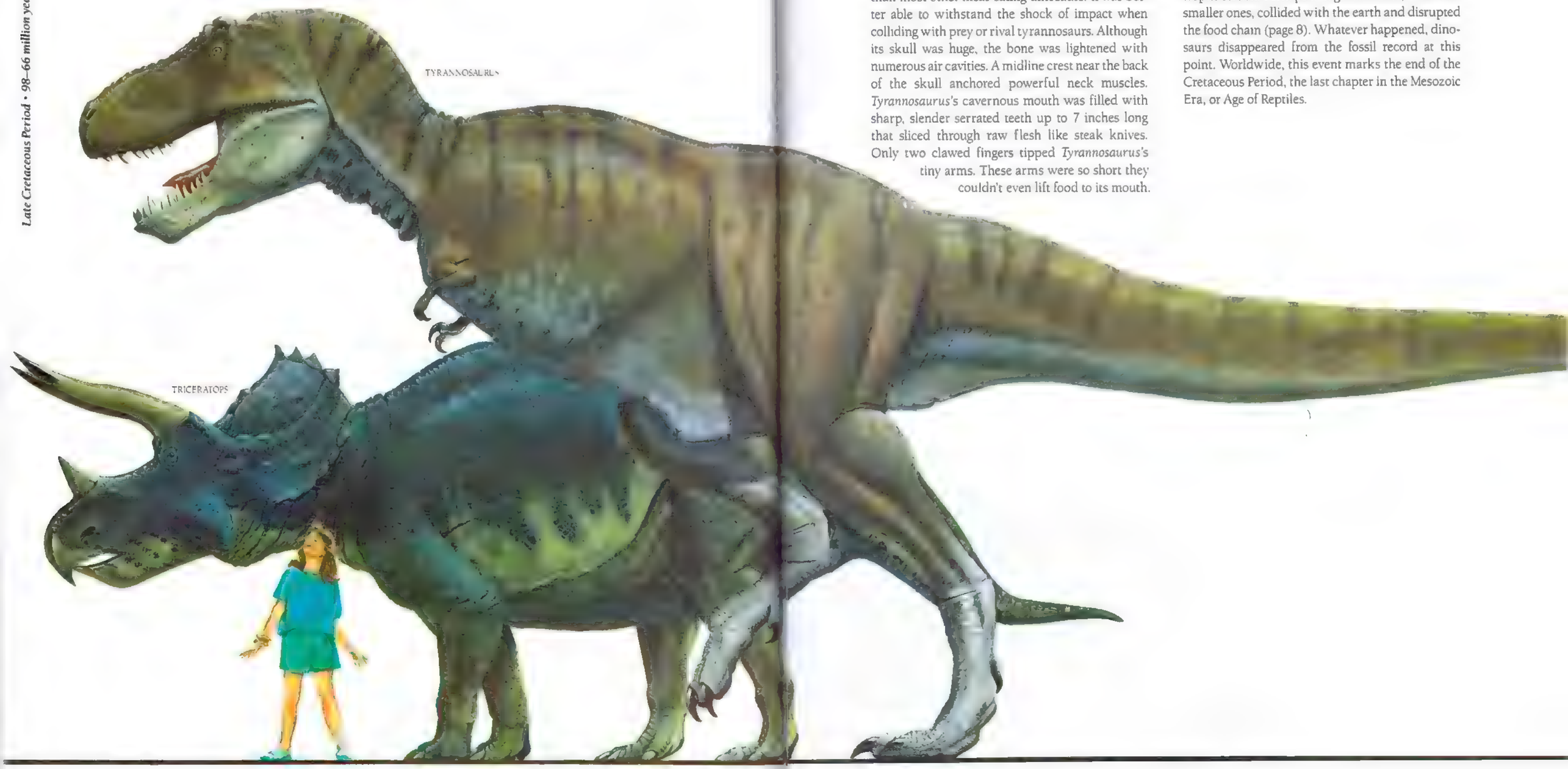
Styracosaurus was the most elaborately adorned of the ceratopsians, plant-eating dinosaurs identified by their large head shields, horns, and parrotlike beaks. In contrast to its desert-dwelling relative *Protoceratops* (page 52), *Styracosaurus* was a woodland creature with a shorter tail. Its legs were heavily muscled, not only to support its great weight of 6,000 pounds but also to charge adversaries. *Styracosaurus* was decorated with huge horns along the rim of its shield. These would have not only protected its neck and back from attack but also intimidated predators and rivals alike. If bluffing failed, scaly *Styracosaurus* would not hesitate to charge at an adversary and drive its deadly 2-foot-long nasal horn deep into its enemy's belly.

Triceratops

(try-SER-uh-tops) "three-horned face"
Archosauria • Dinosauria • Ornithischia • Ceratopsia
Late Cretaceous • Alberta to the Dakotas • 27 feet long

The largest, last, and most widespread of all the ceratopsians was *Triceratops*. Like *Styracosaurus* (page 57), this well-protected plant eater had a head shield, a parrotlike beak, and horns. In the case of *Triceratops* the nasal horn was rather small, but the pair over its eyes were huge, up to 3½ feet long. Two males might have locked horns like cattle, pushing and shoving each other until one gave up. Brow horns were also tremendous weapons for goring tyrannosaurs.

Weighing up to 12,000 pounds and standing 9½ feet tall at the shoulder, *Triceratops* was like a bull, dangerous when provoked. Its huge beak and powerful shearing teeth could slice fibrous and woody plant food that no other dinosaur could handle.



Tyrannosaurus

(tie-ran-uh-SOR-uss) "tyrant reptile"
Archosauria • Dinosauria • Saurischia • Theropoda
Late Cretaceous • Texas, Montana, Mongolia • 39 feet long

Standing 18 feet tall and weighing 15,000 pounds, *Tyrannosaurus* was the largest meat-eating land animal of all time. This bloodthirsty king of the dinosaurs attacked its prey headfirst, lunging with its monstrous jaws wide open, tearing great chunks of flesh from its terrified victims, dropping them in their tracks or bleeding them to death.

Tyrannosaurus was built much more massively than most other meat-eating dinosaurs. It was better able to withstand the shock of impact when colliding with prey or rival tyrannosaurs. Although its skull was huge, the bone was lightened with numerous air cavities. A midline crest near the back of the skull anchored powerful neck muscles. *Tyrannosaurus*'s cavernous mouth was filled with sharp, slender serrated teeth up to 7 inches long that sliced through raw flesh like steak knives. Only two clawed fingers tipped *Tyrannosaurus*'s tiny arms. These arms were so short they couldn't even lift food to its mouth.

The Final Extinction of Dinosaurs

Dinosaurs began their final decline in number and variety 15 million years before their eventual extinction. They may not have been able to tolerate the changes in weather patterns (droughts, intense heat and cold) brought about by the shifting of the continents. In North America at the time of *Tyrannosaurus*'s reign, only a few species, such as its number-one food source, *Triceratops*, remained.

Then out of the blue, 66 million years ago, catastrophe struck. Perhaps a huge meteorite, or several smaller ones, collided with the earth and disrupted the food chain (page 8). Whatever happened, dinosaurs disappeared from the fossil record at this point. Worldwide, this event marks the end of the Cretaceous Period, the last chapter in the Mesozoic Era, or Age of Reptiles.

Rhamphosuchus

(ram-foe-SOOK-uss) "prow beak crocodile"
Archosauria • Crocodilia • Eusuchia • Gavialdae
Pliocene • India • 50 to 60 feet long (est.)

Following the extinction of the dinosaurs, only the small, cold-blooded sprawling reptiles somehow survived. But the end of the Age of Reptiles did not mean an end to reptile giants. Though never as large as the giant dinosaurs, some of the largest specimens of lizards, snakes, turtles, and crocodilians evolved during the Age of Mammals.

The largest reptile of the Tertiary Period was *Rhamphosuchus*. Similar to the modern gavial, a 20-foot-long fish-eating crocodilian with an extremely narrow snout, *Rhamphosuchus* was nearly three times the length of a gavial. Only a few pieces of its 4-million-year-old fossil skeleton have been discovered, so we can only guess at what most of it looked like. Its long, slender snout suggests that *Rhamphosuchus* fed solely on fish that it snared with quick sideways snaps. Like modern crocodiles, *Rhamphosuchus* probably spent much of its time lurking near the surface of rivers and lakes or on the shoreline sunning itself. (See also pages 21 and 43–45.)

Champsosaurus

(champ-suh-SOR-uss) "crocodile reptile"
Choristodera • Champsosauridae
Late Cretaceous–Eocene • Western United States • 8 feet long

Living 50 million years ago, *Champsosaurus* was an aquatic near-lizard that looked like a small crocodile. With nostrils at the tip of its long, narrow, tooth-lined snout, this fish eater snorkled air while resting its feet at the bottom of shallow ponds. Its skull was quite broad and housed large jaw muscles. Although its feet were probably webbed, *Champsosaurus* used its tail to swim, like a crocodile.

Megalania

(megg-uh-LANE-ee-uh) "great ripper"
Lepidosauria • Squamata • Lacertilia • Varanoidea
Pliocene • Australia • up to 22 feet long (est.)

The largest land lizard of all time was *Megalania*, related to the largest living lizard, the 10-foot-long Komodo dragon. So far only fragments of *Megalania* have been discovered, but its resemblance to living species helps us figure out what it looked like. Armed with large curved and serrated teeth, this aptly named "great ripper" would have been the largest predator in Australia 2 million years ago when giant kangaroos and wombats roamed that continent.

Megalania had fewer but larger teeth than the Komodo dragon, larger legs, and a shorter tail. It may have been as good a swimmer as well. *Megalania* probably ambushed its prey by rushing out from its hiding place in the brush. Its large jaws could have clamped down on a small victim. A large marsupial could have escaped after being bitten, but probably would have died from loss of blood or infection some days later. A smelly carcass would have attracted every *Megalania* in the area. Like related lizards and snakes, this giant lizard had a deeply forked tongue that was always "tasting" the air for odors. (See also sea lizards, pages 40–42.)

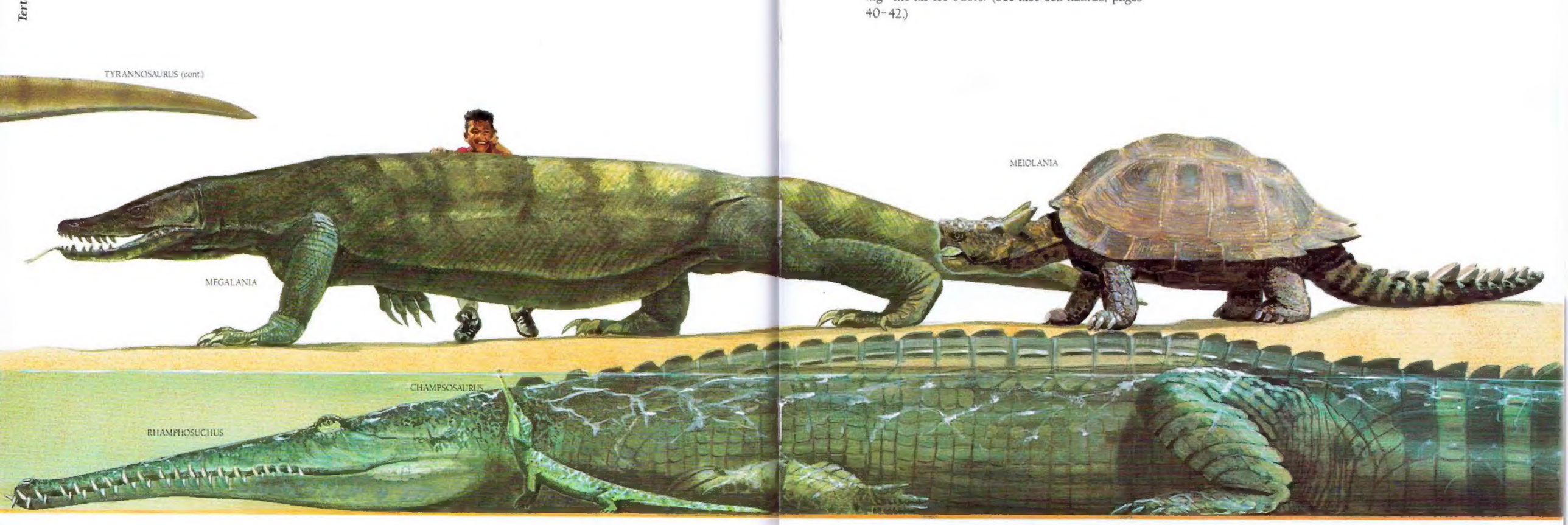
Meiolania

(my-o-LANE-ee-uh) "lesser ripper"
Testudinata • Chelonia • Cryptodira • Baenoidea
Pliocene • Australia • up to 14 feet long (est.)

Meiolania was one of the biggest land turtles of all time, and it was unlike any living today. Like many Australian animals, *Meiolania* was a "living fossil," with features seen in many primitive turtles, such as *Proganochelys* (page 19), which had become extinct 200 million years earlier.

Unlike most modern turtles, *Meiolania* was unable to withdraw its 2-foot-wide head beneath its shell. Instead, large cowlike horns projected from the rear of its skull to protect its neck. *Meiolania*'s long tail was hardened with rings of bone. At its tip was a bony club like that of the ankylosaur *Euoplocephalus* (page 55), which may have been used against attackers. *Meiolania*'s enemies would have included *Megalania* and crocodiles.

Originally *Meiolania*'s fossils were confused with those of the previously discovered *Megalania*, hence the misnomer "lesser ripper." Actually it was a peaceful, lumbering plant eater that lived on the continent and also on a tiny remote island free of predators near Tasmania, 2 million years ago.



Glossary

amniotes Backboned animals that protect their embryos in a closed sac formed by a thin tissue (the amniotic membrane); specifically reptiles, birds, and mammals.

amphibians Cold-blooded, backboned animals that breathe with gills underwater when young and with lungs on land as adults, such as frogs and salamanders.

archosaurs A group of reptiles that includes crocodilians, pterosaurs, dinosaurs, and their immediate ancestors; and also birds.

birds Warm-blooded, backboned animals with feathers and wings; most can fly. Descended from small meat-eating dinosaurs.

canine teeth Large, pointed teeth between the front teeth (incisors) and cheek teeth (or molars). Found in mammals and early synapsids such as cynodonts.

cheek teeth Teeth along the sides of the jaws. In mammals they are called molars and premolars.

cold-blooded Animals that get most of their body heat from their surroundings.

continental shelf The shallow underwater plains bordering the continents.

crocodilians A group of reptiles, usually with long, flat heads, that includes crocodiles, alligators, gavials, and their ancestors.

cycad A plant that looks like a palm or fern but has seed-bearing cones like a pine.

cynodonts Therapsids (synapsid reptiles) with many mammal-like features. Some were ancestors of the mammals.

dinosaurs Extinct land reptiles, usually large, with legs placed directly under their bodies instead of splayed out to the sides as in lizards.

embryo An unborn animal during the earliest stages of its development.

evolution Changes in the features of a group of living things, through time, that are passed on to the descendants.

extinct No longer existing; specifically, when all of the individuals of a particular species are presumed to be dead.

fangs Extra-long, sharp teeth.

fossil Any remains or traces of a once-living thing that have been preserved in rock.

gills The blood-filled organs that most fish and young amphibians use to obtain oxygen from water for breathing.

gizzard stones Rocks or grit deliberately swallowed and stored in a bird's or reptile's gizzard (a pouch in the lower stomach) and used to grind up unchewed food.

incisors The front teeth of mammals and early synapsids such as cynodonts, usually shaped for nipping or cutting.

insulation A covering such as feathers, hair, or blubber that keeps an animal warm.

invertebrates Animals without a backbone, such as insects, mollusks, and worms.

mammals Warm-blooded, backboned animals with fur or hair that feed their young with milk from the mother's body, such as humans, elephants, and whales.

mollusks Cold-blooded, backboneless animals with soft bodies that are usually enclosed in a hard shell, such as clams and snails.

membrane A thin, soft, skinlike sheet of plant or animal tissue.

metabolism The way the body uses air, water, and food as fuel for movement and growth.

meteorite A rock from space that reaches the earth's surface.

ornithischians Plant-eating dinosaurs that have a beak on the lower jaw, teeth shaped for cutting or chopping plants, and birdlike hipbones in which the pubic bone, when present, points toward the rear.

ORNITHISCHIAN HIP

palate The roof of the mouth in vertebrates. Advanced cynodonts, crocodiles, and mammals have a **secondary palate**, a shelf of bone that separates the nasal cavity from the mouth cavity.

palate teeth Teeth that grow from the roof of the mouth, not the edge of the jaws.

Pangaea A supercontinent formed by the collision of all the other continents. It lasted from the Permian Period through most of the Jurassic Period.

predator An animal that kills other animals for food.

prehistoric The time before written languages existed.

reptiles Air-breathing, backboned animals that lay hard-shelled or leathery eggs and are usually covered with scales, such as lizards, snakes, turtles, crocodilians, and a variety of extinct forms including dinosaurs.

SAURISCHIAN HIP

saurischians Plant-eating or meat-eating dinosaurs that have reptilelike hips in which the pubic bone points down and forward.

sauropsids The branch of reptiles that includes all but the ancestors of mammals and their kin (synapsids).

scales Small, thin, flat, rigid, and rounded (or many-sided) plates forming part of the body covering of most fish and reptiles.

scutes Bony or horny plates that develop in the skin, as in crocodiles.

serrated Notched along the edge like a saw.

species A group of animals or plants with similar characteristics and the ability to breed with one another and reproduce themselves; the basic unit of scientific classification.

synapsids The branch of reptiles that includes the ancestors of mammals and their kin (now extinct); and the mammals themselves.

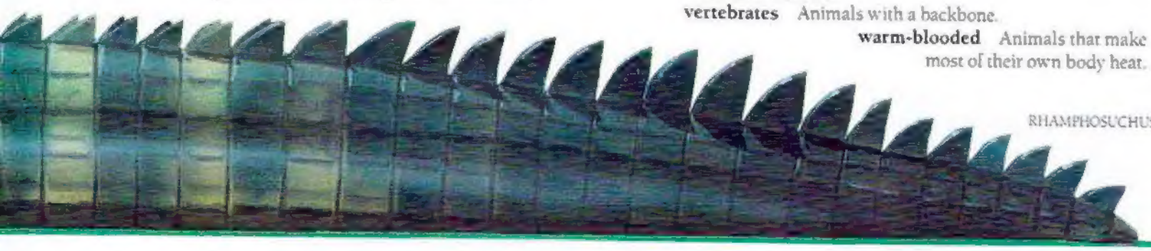
therapsids Synapsid reptiles with a "half-push-up" (semi-erect) or fully erect stance, and usually a short body and tail.

theropods Two-legged, predatory, saurischian dinosaurs.

vertebrae The bones of the backbone, including those of the neck and tail.

vertebrates Animals with a backbone.

warm-blooded Animals that make most of their own body heat.



RHAMPHOSUCHUS (cont.)

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David Peters' super-realistic style of animal portraiture was first seen in his previous book, *Giants of Land, Sea & Air, Past & Present*. He taught himself to paint after graduating from the School of Journalism at the University of Missouri in Columbia. A dinosaur lover since childhood, Mr. Peters devotes every spare moment to dinosaurs when not earning his living as a commercial artist. At present he is working on plans for a museum of prehistoric life. He lives in St. Louis, Missouri, with his wife and two daughters.

Stand under a dinosaur...

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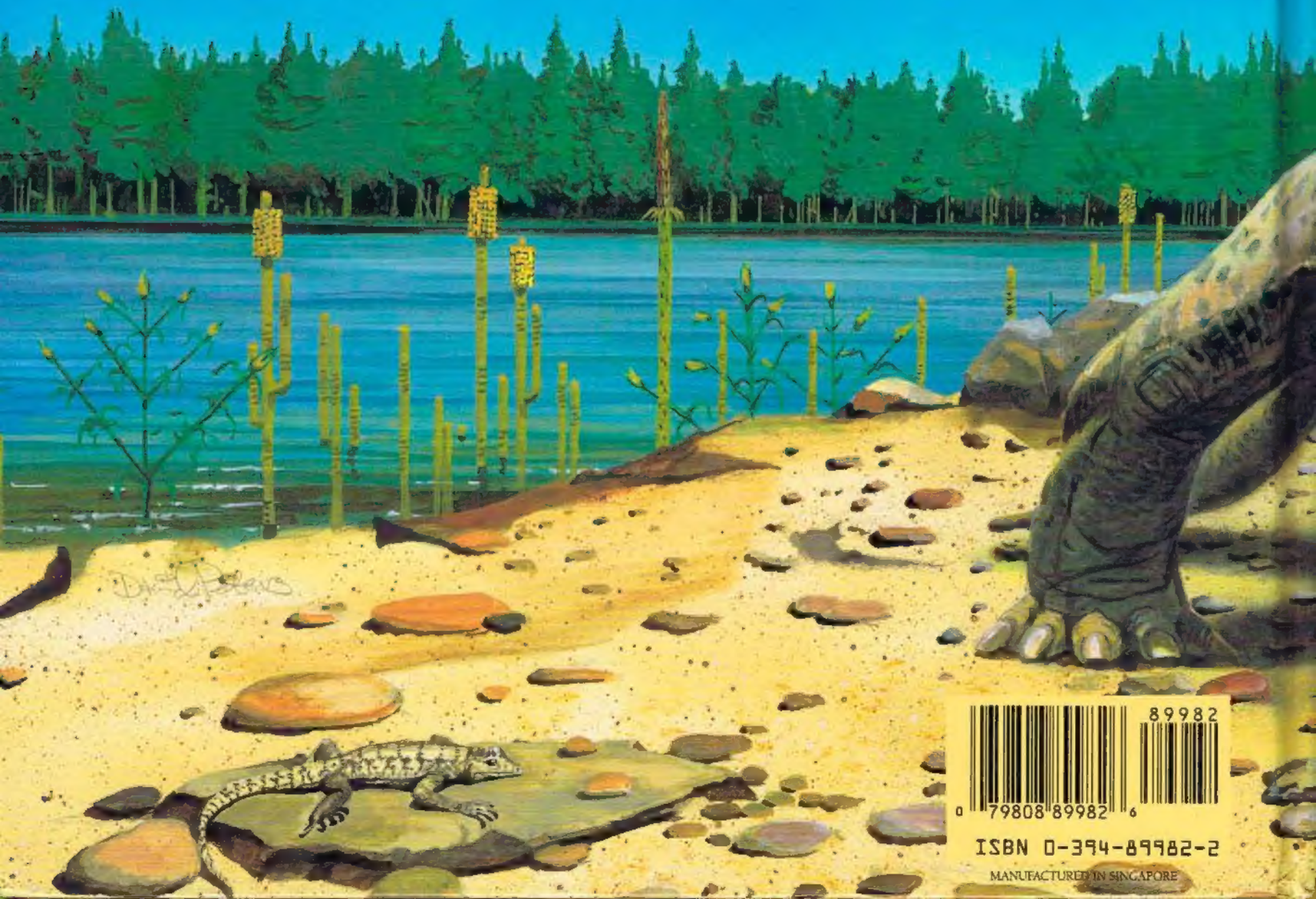
Meet the dinosaurs and their lesser-known ancestors and cousins in this portrait gallery of early reptiles. See just how big these giants of land, sea, and air really were. Striking, full-color paintings—all to the same scale—compare 100 ancient reptiles to us and to each other. Fold-out pages open to show the largest of them all, stretching on and on. And fascinating capsule biographies describe the life—and fate—of these amazing animals that once ruled the earth.



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